POWER

Volume 61 New York, May 12, 1925 *No.* 19

Do You Know What You Are Doing?

IN THE days of gears and belts and rope drives few knew how much power their plants were turning out because there was no practicable way of keeping a continuous record.

One could take indicator diagrams and compute from them the power that the engine developed on a particular revolution and, if the load was at that time about the average, get a fair idea of the day's output.

Or if it was of enough importance to determine the maximum or average load during a given time, as in the case of an acceptance test or the measurement of rented power, a series of determinations could be made with the indicator or dynamometer or one of the power-scales or power meters that were on the market.

But this was done only upon special occasions. Usually, the only gage that a manager or an engineer had of the rate and efficiency at which his plant was working was the amount of product that it turned out and the number of tons of coal that were burned in doing it.

But the coal consumption per unit of product might be increased by poor fuel, short weight, one or more of a dozen things gone wrong in the boiler room, a slipped eccentric or a leaky engine. If the increase were sufficiently serious, the manager might cuss and the engineer grope for the trouble.

In few of the industrial establishments did those in charge know what performance was reasonably attainable with their outfit and under their conditions, how nearly they came to attaining it or why they did not come nearer.

Today the engine in many cases drives nothing but a generator, and a wattmeter will give a continuous or aggregate record of its output. It remains only to weigh the coal as it is burned to have the means of determining, with an accuracy limited only by that of the meter and scales and the observer, just how much power the engine and generator are delivering per pound of coal fed to the boilers.

I have an idea that many a manager, yes, many an engineer, would be disturbed if he really knew how much more coal he was burning per kilowatt-hour than was necessary.

If the return is below what it should be for the fuel burned, attention should be turned to finding out why. And the effort should be not to find reasons why improvement is not possible, but the reasons why you are not doing better — and then remove them if they are to be gotten rid of.

If the coal appears to be up to quality, put a water meter on your boilers and see how much water a pound of it evaporates. The average industrial plant boiler-room efficiency is around 56 per cent. Good management of ordinary apparatus will bring it up to between 70 and 80.

Then see what becomes of the steam after it is made. A resetting of the engine valves, the covering of exposed surfaces, stopping of leaks, saving of spent steam and condensate returns, proper use and care of heaters and especially the greatest practicable use of exhaust steam may cut down your coal cost per unit of product in a way that will surprise you.

And you won't have to buy a new plant to do it, either—only a pair of platform scales and perhaps a water meter to start with.

F. R. Low

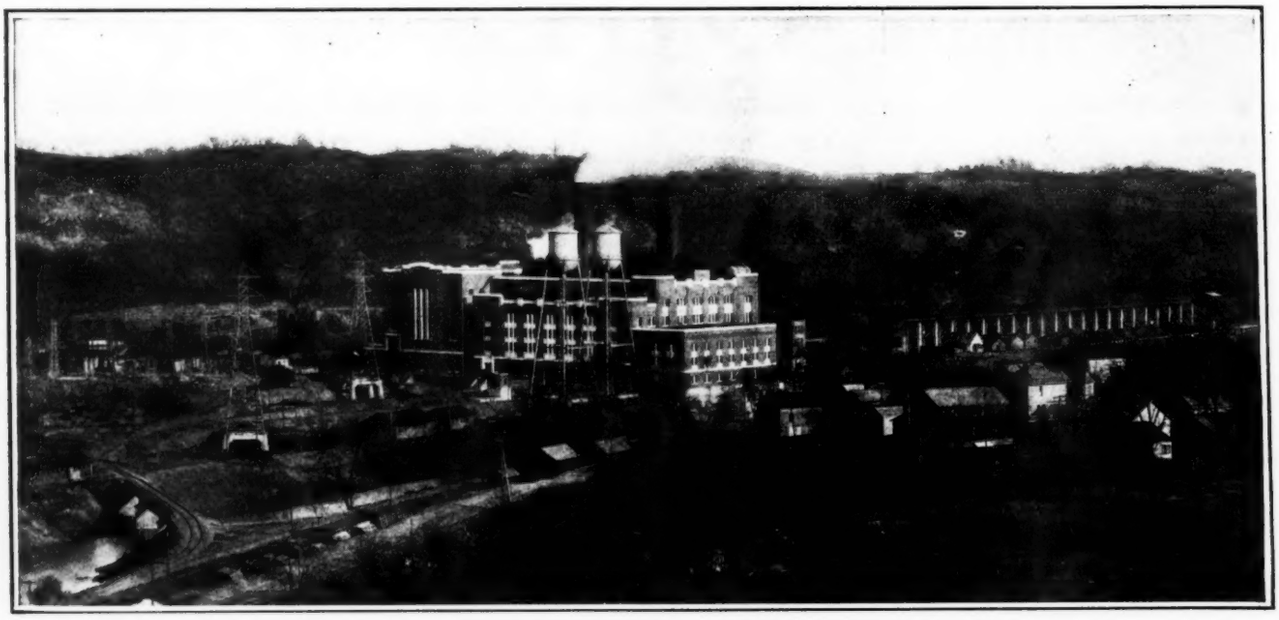


Fig. 1—Philo station of the Ohio Power Company

Operating Results at Philo

Ohio Power Company's Plant Sets New Record for Thermal Efficiency—Reheating Proves of Advantage—Economizers Used with Air Preheaters

RUMORS have been current that the Philo station of the Ohio Power Company was delivering energy to the transmission lines at a fuel consumption equivalent to a pound of high-grade coal per kilowatt-hour. This, together with a desire to ascertain the facts as to the value of the reheating system, was the ground for a visit to the Philo plant.

This station is about ten miles below Zanesville, Ohio, on the Muskingum River. Between the villages of Philo and Duncan Falls is a fall in the river which had its head raised by a dam. A canal leaving the river above the fall was formerly used by towboats, but fell into disuse when a lock was installed.

PHILO OPERATING RECORDS

Week of	1925 April 11	1925 April 18
Plant Thermal Efficiency, net, per cent	23.86	24.88
B.t.u. per kw.-hr. output on line	14,315	13,715
Coal per generated kw.-hr., lb.	1.25	1.25
Coal per kw.hr. output, lb.	1.32	1.32
Total kilowatt-hours generated	5,581,000	5,312,000
Total kilowatt-hours output	5,270,000	5,020,130
Kilowatt-hours for auxiliaries	223,600	217,230
Auxiliary power to generated power, per cent	4.01	4.09
Total coal consumed, lb.	6,962,000	6,624,000
Total water to boilers, lb.	50,525,000	49,559,000
Total water treated, lb.	1,741,000	1,641,080
Average plant water rate, lb. per kw.-hr. output	9.58	9.87
Average plant water rate, lb. per kw.-hr. generated	9.05	9.33
B.t.u. per lb. coal as fired	10,845	10,390
Per cent moisture in coal as fired	8.49	10.38
Per cent ash, by analysis	14.74	16.67
Per cent combustible in ash	7.34	6.54
B.t.u. lost in ash per lb. of coal fired	165	166
Ave. steam pressure, lb. gage	535	534
Ave. steam temperature, deg. F.	706	704
Ave. feed water to economizer, deg. F.	169	193
Ave. feed water to boiler, deg. F.	302	313
Ave. temp of flue gas at boiler outlet, deg. F.	569	591
Ave. temp. of flue gas at stack, deg. F. unit No. 1	353	361*
Ave. temp. of flue gas at stack, deg. F. unit. No. 2	.....	254
Ave. temp. of flue gas at economizer outlet	353	356
Ave. evaporation lb. steam per lb. coal	7.26	7.48
Ave. evaporation from and at 212 deg., lb.	9.11	9.20
Factor of evaporation	1.255	1.23
Boiler output, per cent rating	231.65	221.42
Efficiency of boiler, furnace and economizer, per cent	81.6	86.0
Average plant load factor	89.78	81.07

*No air heater on boilers of unit No. 1

The Ohio Power Co. bought up all the water rights at the fall, as well as title to the canal bed and adjoining property, with the intention of obtaining circulating water from the canal.

The plant operates on a base load and has a present capacity of 80,000 kw. in two turbo units with the necessary boilers and other equipment. The maximum future development will not exceed 240,000 kw. by reason of the amount of cooling water available.

High Station Efficiency

That the rumors of a high station-operating efficiency are based on substantial grounds is indicated by the plant records for the weeks ending April 11 and 18, given in the accompanying table. These are the latest operating sheets available.

The plant has been designed for base-load conditions, and consequently each piece of apparatus was chosen with a view of operating at the highest possible efficiency.

One of the unusual features contributing to a reduction in the power consumed within the plant is the source of the condensing water. The old canal already referred to was cleared of submerged logs and deepened to permit sufficient water to enter the headgates for condensing purposes. The water in the canal has a head of from 10.5 to 12 ft. on the condenser, and for eight months of the year the water flows through without pumping. This reduces the station power consumption an appreciable amount.

It was possible to obtain a low-grade coal at attrac-

tive prices, and while it might be expected that the boiler efficiencies would suffer when such fuels are burned, the traveling grate used, while primarily designed to burn small sizes of anthracite, has given excellent results. It is of the type in which the air box is divided into compartments so that the draft may be varied to meet the conditions along the grate. Burning bituminous slack, the blast pressure was observed to be 4 in., while in the front compartment, or air box, the draft gage indicated 3½ in. at 200 per cent rating. To obtain fan speeds suitable for the draft requirements, each forced-draft fan has two motors operating at different synchronous speeds and mounted on the fan shaft. On heavy loads the high-speed motor drives the fan while the slower motor idles.

In the furnace construction no water screens or water-cooled rear furnace arches are used; in fact, the furnaces possess no specially new feature. Some air is introduced along the side walls and over the front arch to prevent clinkering. In operation no unusual difficulty has been experienced with the linings, in the construction of which merely a high-grade firebrick has been used.

The ashes, after passing over the grate dump, are sluiced away and are used at present to fill a part of the old canal at the front of the plant. The water drains off and is piped to the above-ground coal storage, where, by the ground being kept wet, spontaneous combustion of the high-sulphur slack is prevented.

Pressure Conditions

The boilers are similar to those described in *Power*, Sept. 12, 1922, but are built for 650 lb. pressure. The designed plant pressure is 550 lb. per sq.in. with a total steam temperature of 725 deg. F. at the throttle. In operation, although the total temperature is maintained at approximately 720 and the safety valves are set to relieve at 600 lb., it has been found advisable to carry a somewhat lower pressure, ranging from 525 to 550 lb. This is for the reason that the blow-down of the safety valves is from 40 to 70 lb., and in case a turbine drops its load this reserve in boiler pressure will usually permit the safety valves to remain closed while the fires are being slowed down. For example, on one occasion the load dropped from 25,000 to 1,000 kw. without the valves lifting. There has been some discussion and doubt concerning the sealing ability of a high-pressure pop valve after having lifted, but at various times the valves at Philo have opened without showing any leakage as an after effect.

The boilers have both economizers and preheaters, necessitating the use of induced-draft fans, which are located on a gallery above the air preheaters. The furnace gases enter the economizer at the top, pass downward and into the bottom of the plate-type air heater. After passing upward through this heater, they are drawn into the induced fan and discharged out of the stack. To drive the fan, two induction motors are provided coupled to the fan shaft. One is a 250-hp. 870-r.p.m., while the other is a 125-hp. 650-r.p.m. machine. Each has several steps to its speed control, which, with the two motor speeds, give a wider range to the fan delivery.

The air from the preheaters is drawn from the top of the boiler room down past the induced-draft fans, which tends to keep the room cool and at the same time recovers a slight amount of heat. At present four of the boilers have preheaters, and their operation has been so satisfactory that the other boilers will be equipped as soon as the preheaters are received.

Boiler Feed Treatment

Boiler makeup is taken from the canal, and as it carries a large amount of silt as well as chemicals from factories up the river, it is passed through a cold-water treatment system into a 100,000-gal. storage tank. As the boiler system needs it, the water is put through a quadruple-effect evaporator having a capacity of 40,000 lb. per hour. The evaporator has a continuous blow-down, no attempt being made to recover the small amount of heat lost. To eliminate all air, the water receives a final treatment in a deaërator. The boilers are blown down about once in two weeks, although no scaling has been noticed and the concentration of the boiler water is low.

Each of the two turbines is rated at 40,000 kw. at 95 per cent power factor and has bleeder connections for feed-water heating. It is bled at the sixth stage to supply steam to the air ejector on the condenser; bled steam from the twelfth stage goes to the evaporators, the building's heating system and to the open heater, while the steam from the sixteenth stage goes to the extraction heater, the condensate from this closed heater being fed into the hotwell through a loop. The steam passing the turbine gland goes to a closed heater. The path of the feed water is from the hotwell through the sixteenth stage extraction heater, to the twelfth stage open heater and through the gland-steam heater into the economizer. All bleeder lines have special non-return valves to prevent steam re-entering the turbine when the throttle is closed.

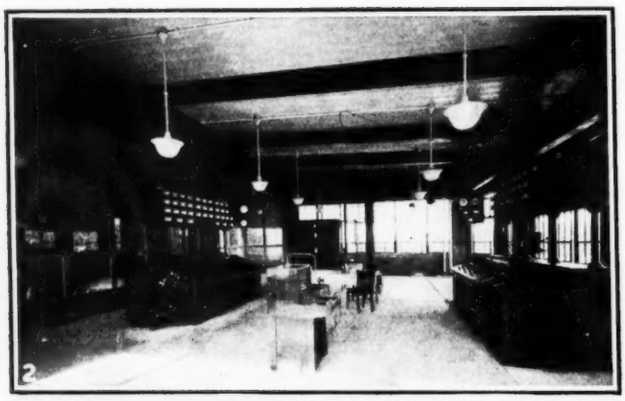
Seamless Tubing for Piping

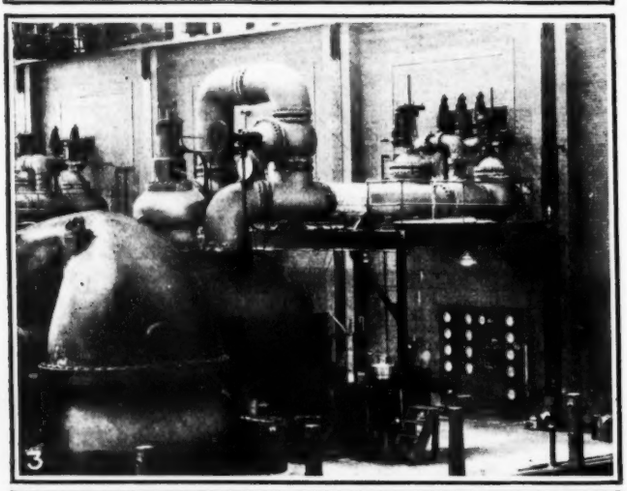
The steam lines are made of seamless tubing with Sargol joints, the flanged edges of the pipe being welded to insure steam-tightness. The steam lines pass out at the ends of the boiler settings and joint into horizontal runs along the boiler fronts, as shown in Fig. 7. Since the plant is built on the unit system, four boilers are piped to each of the two turbines. Expansion is taken care of by the loop sections of the lines, which by the plant arrangement are made quite short, and the 725-deg. steam has occasioned no serious piping trouble, although there have been some minor troubles with porous and deformed valve bodies.

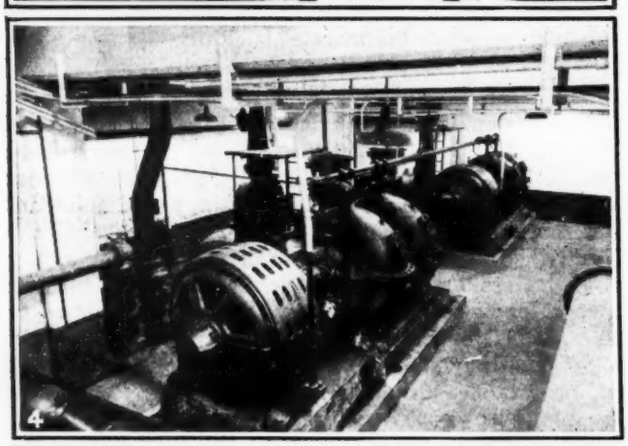
The turbines are arranged for reheating, the steam being taken from the seventh stage and returned to the eighth. Only one boiler for each turbine unit is equipped with the reheater, this being sufficient to supply the reheating requirements. This boiler is fired in accordance with the reheating demands, the exit reheat temperature being maintained as close to 720 deg. F. as possible. The generation of steam in this boiler is a secondary service. The pressure of the steam into the reheater depends upon the turbine load; at 40,000 kw. the pressure is 150 lb., dropping to 47 lb. with a 10,000-kw. load. The plant designers expected a pressure drop through the reheater of 10 lb., but in operation the pressure difference is only from 4 to 5 pounds.

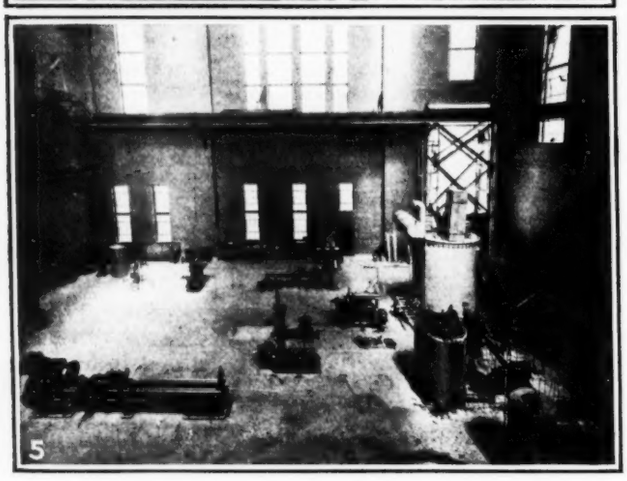
Reheater Safety Devices

In the event that the turbine dropped its load, unless safety devices were used the steam in the reheater lines would continue to flow into the turbine, causing









it to race. In addition, with the flow into the reheater discontinued, the temperature of the reheater elements within the boiler would become so high as to destroy the metal.

These contingencies are cared for by simple and effective devices. The reheater return line, as will be seen from Fig. 3, is equipped with a throttle valve which, when the load is lost, automatically closes through an electrical control, thereby preventing the steam in the reheater line from entering the lower stages of the turbine.

The same control opens six doors, seen in Fig. 7, on the front of the boiler and also shuts down the forced-draft fan. In this way the temperature of the reheater elements and the contained steam does not reach dangerous values. As an additional safeguard the reheater line is provided with four 6-in. safety valves, as shown in Fig. 3. It has been found that the reheater pressure rises but a few pounds when the automatic valve closes, and the temperature increase is likewise small.

The reheater has two gate stop valves as well as a crossover valve. These are electrically connected so that the plant can be run without the reheater by closing the stop valve and opening the crossover, which permits the steam to flow through the crossover to the lower stage. In starting, the reheat boiler is fired up so that the reheater is warmer than the high-pressure steam. The gate valves are then gradually opened and the crossover valve closed, whereupon the reheating cycle starts functioning.

Test with Reheating

On test the steam consumption was 9.6 lb. per kilowatt-hour without reheat, corresponding to 12,080 B.t.u. per kw.-hr. to the turbine. With reheat and the increased efficiency due to the high superheat in the steam to the eighth stage the steam consumption was reduced to 8.18 lb. per kw.-hr., corresponding to 11,600 B.t.u. per kw.-hr. to the turbine. In addition the use of the reheater gives the turbines a greater load capacity.

The boiler room is not provided with any automatic boiler control. It has been the experience of the management that a well-trained force of intelligent firemen will obtain results in boiler operation equal to those obtainable by a control system.

Every effort is made to provide the boiler operators with all the instruments needed to obtain the best efficiency. As shown in Fig. 8, on a sloping table control laid alongside each pair of boilers are placed the following instruments:

Electric control for the induced draft fan;
Electric control for the forced-draft fan;
Indicating steam-flow meter;
Duplex flue-gas temperature recorder to show temperature in and out of economizer;
Feed-water temperature recorder;
Draft-pressure recorder, to show draft in forced draft from duct;

Fig. 2—Switchboard room is on a gallery overlooking turbine room. Fig. 3—Turbine reheater lines with crossover connection. Fig. 4—Motor-driven circulating water pumps. Fig. 5—A well-equipped machine shop in basement at one end of turbine room.

Differential draft gage to show draft in each stoker compartment;
Differential draft gage to show draft loss through economizer and air heater;
Temperature recorders for the reheater in and out temperatures;
Pressure recorders for reheater in and out pressures;
Flue-gas temperature recorder;
Integrating steam-flow meter.

The turbines have shown a reliability equal to that encountered in most central stations. Unit No. 2 was started Sept. 9, 1924, and went into commercial service Oct. 14. Up until March 15 it had run 90 per cent of the time. However, due to filings getting into the turbine it was necessary to take it out of service and replace some of the blading. Up to March 15 it had operated 3,306 hours and had been out of service 161½ hours, of which time it had been available 144 hours but was not used. The total output was 87,917,000 kw.-hr., of which 77,914,000 was put upon the transmission lines.

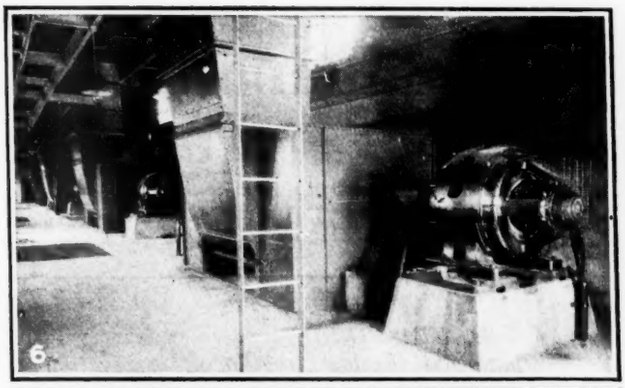
Turbine No. 1 went into service Feb. 24, and up to March 15 it had operated 391 hours and had been out of service only 65 hours. During this time a total of 10,003,000 kw.-hr. was generated. On March 3 the reheater was put into action and the turbine operated 231 hours with reheating. Owing to lack of dowels in the yoke at the steam end bearings, the turbine casing shifted about 0.030 in. This has been rectified by doweling.

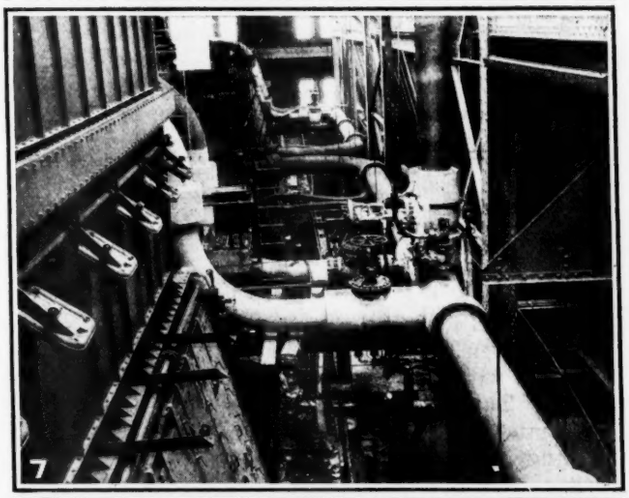
While the high thermal efficiency means low operating costs, of equal influence upon the cost of producing energy is the situation of the station with reference to the Ohio coal fields. The coal in this territory has a low heat value and carries considerable sulphur. The slack grades cannot be stored at the mine mouths without danger of firing. The Philo station has a 300,000-ton under-water storage to be described in a later issue of *Power* and consequently is in position to take a large amount of slack at times when the market is weak and the mine operator is confronted with the problem of disposing of it before it fires. This is probably equivalent to an advantage of approximately 60 cents per ton or more.

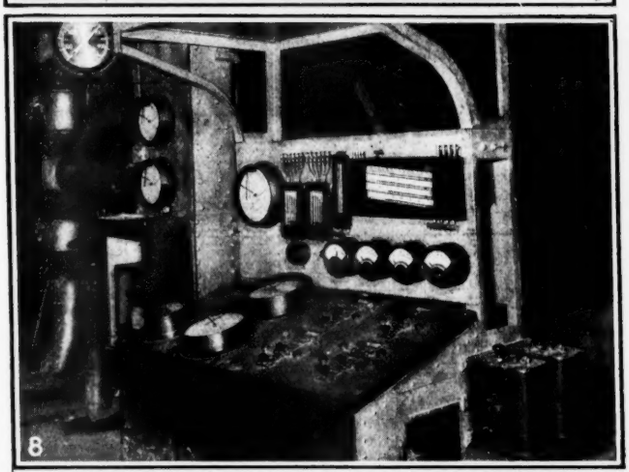
After the plant was put into service, no radical changes were found necessary, indicating that the planning studies were well and logically conducted.

The Ohio Power Co. owns a number of electric utilities in Ohio and has several generating stations in Ohio, interconnected by high-tension transmission lines. The offices of the company are: R. E. Breed, New York, president; Geo. N. Tidd, New York, vice-president; E. H. McFarland, manager of plants; E. A. Johnsen, mechanical engineer; M. L. Sundeband, electrical engineer; J. Borgin, Philo Plant superintendent.

Sargent and Lundy, Inc., Chicago, Ill., were the consulting engineers on the design and construction of the plant.







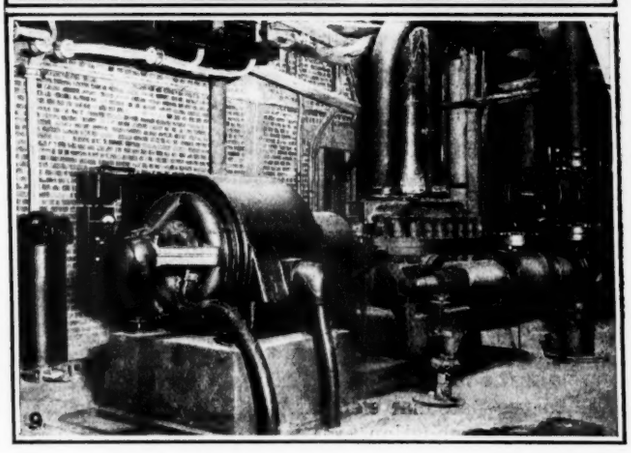


Fig. 6—Induced-draft fans have two motors to give capacity control. Fig. 7—View of boiler room showing steam piping layout. Fig. 8—A control board is placed in front of each boiler. Fig. 9—Motor-driven boiler-feed pumps.

Balancing Combustible in Ash Against Excess Air

By GEORGE E. GASTER

IN STOKER-FIRED furnaces an attempt to burn out the last fraction of combustible from the ash may result in excessive dilution of the gases by air leaking through the back part of the fire. This article discusses tests made to determine what percentage of excess air gives the highest over-all efficiency. The investigation shows that cutting down the excess air too far may actually decrease over-all efficiency by markedly increasing the combustible loss.

TABLE I shows some of the results obtained in a test on a 7,000-sq.ft. horizontal water-tube boiler, set with an underfeed stoker equipped with dump plates. The main object of this set of tests was to determine the boiler efficiency at different ratings, but in studying the results obtained, it occurred to the writer that they offered an excellent opportunity to investigate the relation between the loss due to excess air and that due to combustible in the ash.

Table II gives the average proximate analysis of a sample of coal from the same mine as that used, but

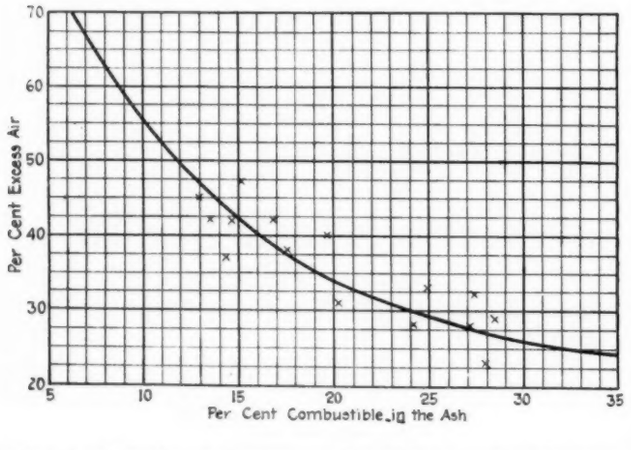


Fig. 1—Relation between combustible in ash and excess air for this particular installation and fuel

the ultimate analysis was made from a previous shipment.

The relation between excess air and combustible loss is shown graphically in Fig. 1. Since the results of the test do not cover a very wide range, there may be an error in the location of the extreme ends of this curve, due to the personal element.

In the combustion of a pound of fuel there is required a certain definite amount of air, which can be figured from the amount of carbon, hydrogen, oxygen, and sulphur in one pound of fuel.[1] This particular coal required, theoretically, 10.6 lb. of air for combustion. For an ash containing 8 per cent combustible Fig. 1 shows the excess air to be 62 per cent. With a

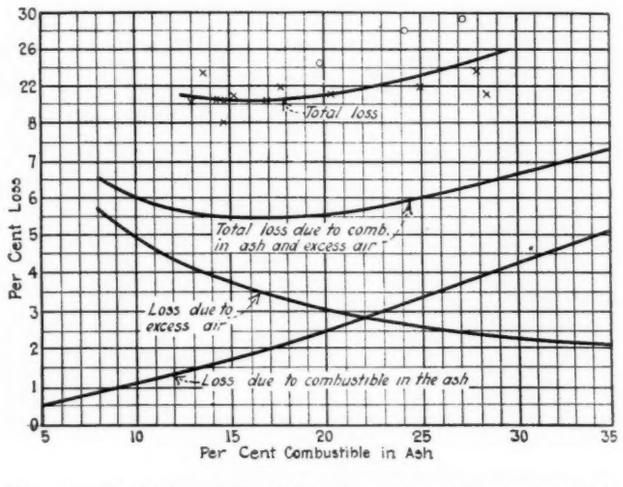


Fig. 2—Variation of individual and total losses with the percentage of combustible

temperature difference between the flue and the room of 500 deg., the flue loss due to this excess amounts to 5.7 per cent of the heat in the coal.

The corresponding excess air losses for various percentages of combustible in the ash, figured in this manner, are plotted in Fig. 2, as are likewise the losses directly due to the combustible in the ash. The latter are figured on the assumption that the combustible in the ash has a heat value of 14,600 B.t.u. per lb., in other words that it is pure carbon. This assumption involves a negligible error. The loss due to the sensible heat in the ash is neglected. This decreases as the excess air increases.

Of greater interest than the curves showing separately the loss due to excess air and that due to combustible in the ash is that giving the total of these two losses. It will be noted that for the particular case in hand this total loss reaches a minimum at about 16 per cent of combustible in the ash, showing that for smaller amounts of combustible than this the saving in combustible is more than counterbalanced by the additional loss due to excess air.

The top curve, marked "total loss," is plotted directly from the boiler efficiency as shown on tests and includes loss due to incomplete combustion of the gases and "radiation and unaccounted for" as well as that due to combustible in the ash and excess air. It should be

[1]Allow 11.52 lb. of air per pound of carbon, 4.32 lb. per pound of sulphur and 34.56 lb. per pound of free hydrogen, the latter being the total hydrogen minus one-eighth the oxygen.

noted that this curve reaches a minimum at about the same percentage of combustible in the ash as the lower curve. The three points inclosed in circles represent three tests run at extremely high boiler ratings with resulting high flue temperatures and high stack losses.

In summing up the results, it is evident that, for this particular installation and fuel, the best operating

TABLE I—PARTIAL RESULTS OF TEST ON 7,000 SQ.FT. WATER-TUBE BOILER SET WITH UNDERFEED STOKER WITH DUMP PLATES

Test No.	Per Cent CO_2	Per Cent Excess Air	Rating	Efficiency	Combustible in Ash
1	12.8	45	153	79.7	12.9
2	13.5	38	172	78.1	17.6
3	13.0	43	175	81.9	14.6
4	12.5	47	199	79.2	15.1
5	13.0	42	199	79.4	16.9
6	15.3	23	207	76.4	27.9
7	14.2	31	208	78.7	20.3
8	13.5	37	222	79.6	14.3
9	13.0	42	223	79.7	14.6
10	13.9	33	237	78.1	24.9
11	14.5	29	242	78.8	28.5
12	14.1	32	246	78.0	27.4
13	12.9	42	247	76.5	13.6
14	13.3	40	273	75.6	19.7
15	14.5	28	298	72.0	24.2
16	14.5	28	343	70.8	27.1

results are being secured with about 35 to 40 per cent excess air, corresponding to a percentage of combustible in the ash between 16 and 18. However, it will be noted in Fig. 2 that the percentage of combustible in the ash may vary from 12 to 22 per cent without materially decreasing the boiler efficiency. The corresponding range of excess air is from 50 to 31.

It is to be regretted that these tests do not cover a wider range of operating conditions with regard to

TABLE II—ANALYSIS OF COAL USED IN TESTS

Proximate analysis—dry basis	
Fixed carbon, per cent	64.97
Volatile combustible, per cent	22.10
Ash, per cent	9.83
Sulphur (separately determined), per cent	1.82
Moisture, per cent	3.10
B.t.u., dry basis	14,121
B.t.u. as fired	13,683
Theoretical air required per pound as fired, lb	10.6

Ultimate analysis as fired: Carbon, 77.22; hydrogen, 5.00; oxygen, 4.27; nitrogen, 1.86; sulphur, 1.82; ash, 9.83; total, 100.00.

excess air and combustible in the ash. However, they serve to illustrate one method of attacking this problem and at the same time give considerable information as to what results are to be expected.

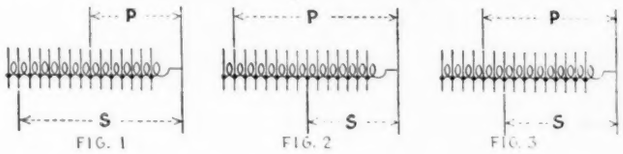
Use of Tapped Auto-Transformers in Testing Motors

By H. B. Hodgins

IT OFTEN happens, especially with organizations having a number of small applications scattered some distance apart over a section of the country, that all the testing of both new and repaired motors is done at one of the small plants. This may be because the distributing of all new apparatus is done from a central purchasing point, because of a centralized repair shop or for various other reasons. But it often happens that the voltage, phase or frequency is different in the outlying stations. Thus the test man may be called upon to test motors with electrical characteristics different from those obtainable where the testing is to be done.

In such a case the simplest way to obtain the desired characteristics is by means of two tapped auto-transformers. Of course, frequency cannot be changed by this means, but both the voltage and the phase can be adjusted to suit the requirements. The same transformers can be used, with a decrease in rating proportional to the change in frequency, for 25-, 40-, 50- or 60-cycle service, although the operation of 25-cycle transformers on 60 cycles, or the reverse, is poor practice.

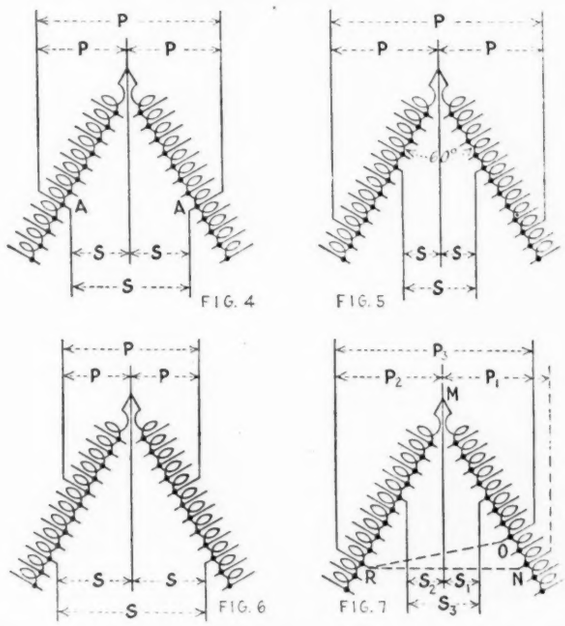
Single-phase testing from a single-, two- or three-phase line is, of course, quite simple. Only one transformer is used, the voltage being adjusted as shown in Fig. 1, in which P represents the incoming or primary line voltage, and S the outgoing or secondary voltage. Each loop represents a definite number of turns on the



Figs. 1 to 3—Changing single-phase voltage with auto-transformers

auto-transformer. In Fig. 1 the secondary voltage is doubled to obtain that required for the motor under test, in Fig. 2 it is halved and in Fig. 3 approximately four-fifths voltage is obtained, as in changing from 550 to 440 volts.

For three-phase testing from a three-phase line the transformers are connected in open-delta or "V," as shown in Fig. 4. In this connection a third transformer may be imagined as extending from A to A, on which the changes are automatically made when the points A are moved. Care must be taken in this hook-up to see



Figs. 4 to 7—Changing three-phase voltage with two auto-transformers

that the voltages are balanced. However, unbalanced incoming voltages can be partly corrected as in Fig. 7, in which the incoming voltage in phase 1 is low. In Fig. 4 the outgoing voltage is the same as the incoming. In Fig. 5 it is $\frac{1}{2}$, and in Fig. 6 it is just double. In Fig. 7, as stated before, the connection is made so as to correct the effect of a low voltage on P_1. Point N is where the connection would normally be made, but on account of the primary voltage being low, the

connection is made to *O*. The effect of this change is to raise the secondary voltage *S*, in the approximate ratio of the distance *MN* to *MO*. However, it must be noted that phase 3 is also affected in the ratio of *RN* to *RO*.

A two- to three- or a three- to two-phase transformation is the most complicated, as it must be made by a variation of the Scott connection, whereby the end of one auto-transformer is connected to the midpoint of the other, as shown in Fig. 8. For balanced line voltage the turns used on transformer *B* will be 86 per cent of the turns used on transformer *A*. This can be understood more easily by considering the lines *MN*, *NO* and *OM*, which represent the resulting voltages.

Fig. 8 represents a transformation from three-phase to two-phase, at the same time changing to one-half the primary voltage. In order to give balanced two-phase secondary voltage from balanced three-phase primary voltage, *TN* must be 86 per cent of *MO* and

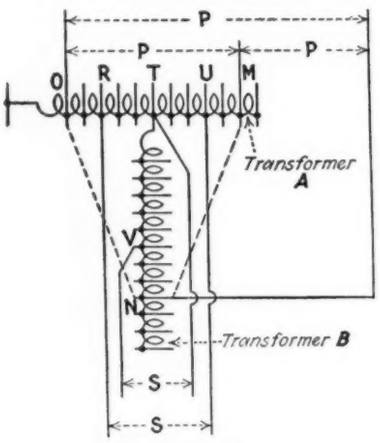


Fig. 8—Changing from three-phase to two-phase with two auto-transformers

RU must equal *TV*. Then the ratio of the primary to the secondary will be as *MO* is to *RU*. The secondary voltage can thus be adjusted by changing either the primary or the secondary taps. In changing from two-phase to three-phase, of course the conditions are just the reverse of the foregoing.

In using any of the connections given, it is advisable to check all the secondary voltages by a voltmeter before connecting the motor. Care must be taken to see that the primary leads are not connected too close together; that is, the maximum possible number of turns for the transformation ratio desired should always be used.

Another point that must be watched is the overloading of the transformers. In using two transformers for three-phase transformation, the total three-phase load should not exceed 1.73 times their name-plate rating. A check should also be made to see that the full-load current value in the coils is not greatly exceeded, although since these tests as usually performed are of short duration, considerable leniency can be allowed on this point.

Most boiler-room losses are kept down only by everlasting vigilance, but insulation, once installed, functions constantly without being watched. For this reason the savings shown by tests or computations are maintained in daily operation without attention on the part of the operating force.

Synthetic Liquid Fuel

Substitutes for gasoline have been on the market for a number of years. There has been little likelihood, however, that such fuels would form a worth-while competitor for gasoline. The fact that processes for producing these fuels have recently been cheapened, indicates that rivalry developing among the makers of artificial fuel may place them in a more effective position for competing with petroleum products.

One noteworthy indication is the assertion at the closing session of the recent meeting of the American Chemical Society that America's wood distillation industry is threatened as a result of German chemistry. A substitute for wood alcohol is manufactured from water gas, under such conditions that its production in America from hard wood may be endangered.

The artificial product is made abroad by passing water gas over a mixture of carbon monoxide and hydrogen in the presence of catalytic materials, which tend to promote chemical combination, at a fairly high temperature and very high pressure. Among the derivatives of this are the lower alcohols. America apparently must pay greater attention to research.

Synthetic petroleums have come to the fore in France, as reported in the March 6 issue of *Engineering*. These can be obtained from catalytic decomposition of castor oil, as well as from oils of other origin. By treating under similar conditions rape seed, olive, ground nuts, palm, copra, fish, whale and other oils, a similar petroleum was obtained.

Slight differences noticed in the various synthetic petroleums obtained did not arise from the different nature of the oils treated, but more from variation in the temperatures of reaction, or from the greater or less activity of the catalytic agent, or, again, from the rapidity with which catalysis was effected. The method followed had been applied both to the raw oils and to those refined.

The actual cost of manufacture of synthetic petroleums being low, the cost of the products themselves depended mainly upon that of the oils to be treated. A prime necessity, therefore, was to provide for the rational cultivation on a large scale of the suitable seeds and nuts, in order to decrease the cost of vegetable oils much below the market prices now ruling.

When electrical equipment is taken out of service for repair, unless well trained and careful, an operator may attempt to ground a live conductor, with probable serious consequences. Cases of fatal injuries and damage to apparatus have been known to occur because of an attempt to ground a live conductor; and because of the human element, trouble of this nature may develop at the most unexpected moment, even where only experienced operators are concerned, and where safety rules and safety devices are provided. And the possibility of trouble is not removed even after conductors are safely grounded, for interruptions to service and damage to equipment have resulted from the failure of the operator to remove the grounding cables before energizing the conductors, to put the circuit back into service again. On this account the grounding of conductors that workmen are working on is sometimes objected to, but for safety's sake grounding is to be recommended.

Operation of High-Speed Traction Elevator Control

Describes in Detail the Circuits and Their Function for a Type of Controller Used on High-speed Traction-Elevator Machines

By WARREN HILLEARY
Superintendent, Royal Indemnity Company, New York City

TRACTION elevator machines, one type of which is shown in Fig. 1, have within the last few years come into very general use and to a large extent have superseded the drum-type machine. The control for traction machines offers special problems, and a wide variety of controllers have been developed for this class of equipment. A front view of an Otis Elevator Company's type MF-4-B controller is shown in Fig. 2 and a diagram of the connections in Fig. 3. Although this type is not one of the latest built by this company, it is representative of a type that has a wide use.

The main line or potential switch A in the figures carries the current for all parts of the elevator mechanism except the motor field coils and the holding coil A_c on the switch. Holding coil A_c is energized

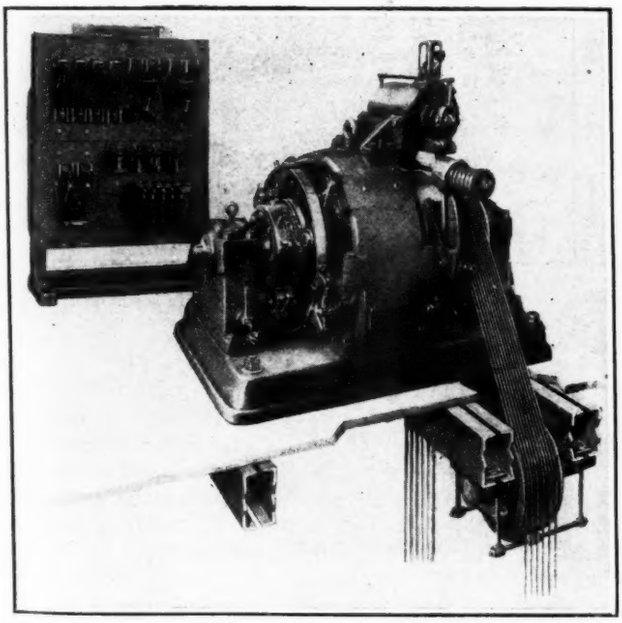


Fig. 1—Direct-type traction elevator machine

by a circuit from the positive main, through fuse F_1, contact H' of magnet H, safety switch N in the car, switch M, which is mounted on the safety plank under the car and opens when the safeties are set. From switch M the circuit is through contact G' on the governor, upper contacts of hatchway switch I_h, lower contacts of hatchway switch E_h, coil A_c on the potential switch A, upper contacts of hatchway switch E_h, lower contacts of hatchway switch I_h to switch P on the controller and the negative side of the line. A simplified diagram of this circuit is shown in Fig. 4. If the circuit through coil A_c of the main-line switch A is broken, the switch will open and the feed wires to the motor will be interrupted and the motor stopped when any of the following contacts are separated:

1. Contacts H' of switch H. The coil of this switch is in series with the motor's field winding and contacts H' are held closed as long as the field circuit is energized. Opening of the field circuit allows contacts H' to open, which in turn causes potential switch A to open and stop the motor.

2. Contacts of switch N. This switch is a safety device placed close to the control switch in the car. In case of emergency the elevator operator may open it and thus open the potential switch A.

3. Contacts of switch M. This switch is placed on the bottom of the car and is operated by the car safeties.

4. Governor contacts G'. The governor has two fixed contacts and two movable contacts. When the car speed increases above normal, first contacts G'' close, thus short-circuiting part of the shunt-field resistance R_s, which should slow down the machine. If the speed keeps on increasing, contacts G' break the circuit through the coil of the main-line switch A and stop the machine.

5. The contacts of hatchway switches I_h and E_h, operated by a cam attached to the car, limit the travel of the car at the terminal landings. Under normal conditions the elevator will automatically come to a stop when the cam on the car opens switch K_h, at the top or D_h at the bottom. If, however, for some reason motion continues, the opening of the contacts of switches I_h or E_h will open the main switch A and at the same time contacts A' and A'' will be closed, causing a strong dynamic-braking effect by short-circuiting the armature through a section Y of the armature shunt resistance.

Reversing Switches Have Two Coils

Each of the reverse switches B and C has two coils B' and B'' and C' and C'' respectively. The lower coils are connected shunt and the upper coils are in series with the armature. The shunt and series coils work in opposition to each other, having, however, separate paths for the two magnetic fluxes. When the shunt coil B' of switch B is energized, top contacts B_1 close and bottom contacts B_2 open. This completes the armature circuit from the positive line terminal through contacts A_1 of potential switch A, contacts B_1 on reversing switch B, left-hand contact C_2 of switch C, series coils B'' and C'' of switches B and C, through the armature and series starting resistance R_2 right-hand contacts C_2 of reversing switch C, through series starting resistance R_1, contacts A_2 on the potential switch and to the negative side of the line. At the

same time a circuit parallel with the armature is made, branching off at Z and through a section of the armature shunt resistance between 8 and 9 to contact G_a through the top half of the contacts of switches F, E and D to X and through series starting resistance R_2 to to the negative side of the line as did the armature current. The effect of this parallel resistance is to give a very slow speed.

The effect of the series coils B'' and C'' on reverse switches B and C is as follows:

Suppose the shunt coil of B to have been energized and as a consequence its top contacts closed and its lower contacts opened. On account of the motion of the magnet plunger to its extreme position under the influence of the shunt coil, the energizing of its series coil, which occurs a little later with the closing of the armature circuit, has little effect in opposing the shunt coil. However, as switch C remains in the off position without excitation in its shunt coil, its plunger remains in such a position that the flux generated by its series coil has maximum effect tending to press contacts C_2 tightly together. When the elevator is stopped, current through the shunt coil of switch B is interrupted, but the current through the switch's series coil is not broken until a moment later when the top contacts open, therefore the effort of the series coil assists the weight of the switch armature to return to its off position, thereby securing a quick break of the top contacts. For the reason that the top contacts of the reversing switches B and C make and break the main current, they are arranged two in parallel.

Brake Controlled by Reversing Switches

The reversing switches also control the brake which is kept normally on by springs. When, for instance, switch B closes, contacts B_3 make and B_1 break. The brake-coil circuit is from the positive terminal of the potential switch through contact A_3 on this switch, contacts B_2 of reversing switch B, contacts B_c of a switch mechanically operated by the brake magnet, through the brake coil to contact A_4 of the main-line switch to the negative terminal of the line. As a consequence the brake is released and opens contacts B_c, which connects resistance R_b in series with the brake coil, thus reducing the current in the coil and preventing overheating. At the same time resistance R_p remains in parallel with the brake coil.

When switch B drops out, the current through the brake coil is interrupted, but a self-induced current is maintained through resistance R_p, with the tendency to retain the brake released. When finally switch B returns to its off position, contacts B_1 make and parallel resistance R_p with resistance R_s and R_b in series with the effect of maintaining the current through the coil. The current quickly weakens to the point where the brake-coil plungers separate and allow the brake to set, but shortly before this takes place contacts B_c close again, thus cutting out resistance R_b. This practically short-circuits the brake coil as resistance R_s is low. The result is a tendency to maintain the induced current in the brake coil, which exercises a retarding effect on the magnet cores, so that the brake shoes are gently applied to the brake pulley. By means of resistances R_p and R_s the time lag between the interruption of the brake-coil current and the setting of the brake may be regulated within limits.

Switch C is identical in its functions with switch B, except that B controls the down motion of the car, while C controls the up motion.

Switches D, E, F and G are controlled by the car switch. Switch G is designed to operate first, closing contacts G_s, cutting out section 1 to 2 of series starting resistance R_2 and opening contacts G_a, thereby inserting the portion 9 to 10 of the armature shunt resistance in the circuit across the armature. The closing of contactor G also closes the secondary contacts S_1 which are part of the circuit of the coil of

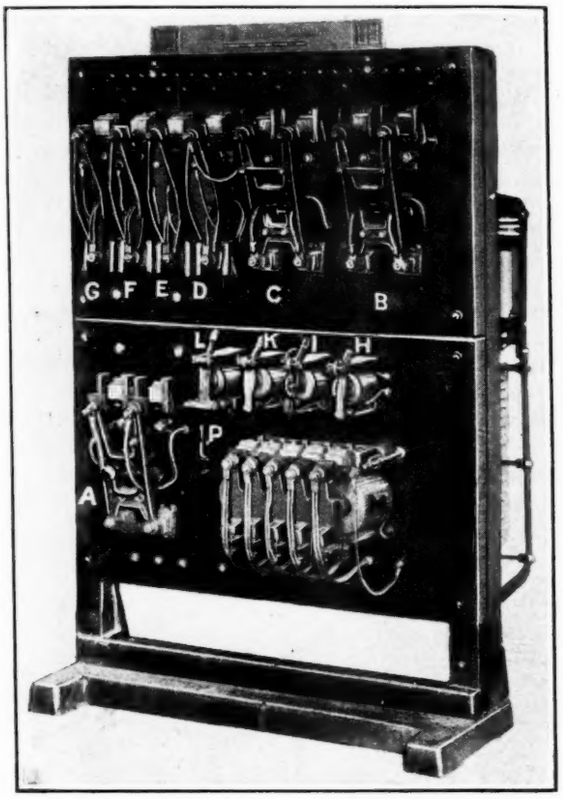


Fig. 2—Front view of an Otis type MF-4-B controller for a traction elevator

switch F, so that F cannot be energized unless switch G has closed. When F operates, the closure of contacts F_s short-circuits all of series starting resistance R_1 and the opening of contacts F_a inserts portion 10 to 11 of the armature shunt resistance across the armature. The closure of secondary contact S_2, which is part of the energizing circuit of switch E, permits the operation of this switch only when F has closed, except under certain special conditions, which are discussed later.

The closing of contacts E_s through the operation of switch E has no effect, these contacts being in parallel with F_s. The opening of contact E_a inserts additional resistance in the armature shunt resistance circuit. The right-hand secondary contact S_3 of switch E is to prevent the energizing of D unless E has operated. The purpose of the left-hand secondary contact S_4 is indicated later in a description of magnet I.

The operation of switch D opens contact D_a, thereby opening the armature shunt-resistance circuit. It also closes contacts D_s, thus closing the circuit of the accelerating magnet M, while the secondary contact S_5 allows the insertion of resistance into the shunt-field circuit by the master controller.

Fast- and slow-speed switch L is energized simultaneously with the closing of the armature circuits and receives current from left-hand B_1 contacts at B_f on the reversing switch through resistance R_f, through coil L, to A_1 on the potential switch and to the negative side of the line. As a consequence contacts L_f close and short circuit the shunt-field resistance R_s and permit the motor to start with maximum field strength.

Accelerating magnet M automatically controls series starting resistance R_1 and comprises five switches, each having its own magnetic circuit but all energized by a single coil. This coil is energized when switch D closes contact D_s, the circuit being from M_b, through the accelerating-magnet coil M, contact D_s of switch D, and point M_r on the series starting resistance. Coil M is, as may be seen, in parallel with the armature, and subject to its counter-electromotive force. The switches are adjusted so that, at a certain counter-electromotive force, contact M_1 operates and as the motor accelerates M_2, M_3 M_4 and M_5 close, each successively cutting out a step of the series starting resistance. On the operation of M_5 all the starting resistance is cut out and at the same time the secondary contact M_s is made, which short-circuits coil L, inasmuch as the current, which originally passed through coil L, will be diverted to go from M_s to contacts S_5 on switch D, contact 7 of the car switch through the right-hand side of emergency switch N and to the negative side of the line, in case the car switch is in either of its extreme positions. With these conditions the machine runs at maximum speed. The accelerating magnet M cannot be energized unless switch D has operated. This safety feature prevents the cutting out of the series resistance and placing the motor directly across the line, before the armature-shunt resistance is opened.

Load switch I is in parallel with the armature, being connected to the armature wires at I_a and I_b. It is, therefore, subject to the motor's counter-electromotive force and will not open its contact I_c unless the motor has attained a certain speed. If the motor speed drops below a fixed minimum, the switch will drop out and close contact I_c again. The functions of this switch will be explained later.

Safety switch H is in series with the shunt field and, as explained previously, will open its contact H' in case of failure of the shunt-field current. The opening of contact H' results in opening the potential switch and stopping the machine.

Switch K is connected directly across the line. In case of excessive potential (20 per cent above normal) it operates, closing contacts K_a and short-circuiting magnet H. The latter opens its contact H', stopping the machine in the manner previously described.

With the single-pole knife switch P closed to the up position as in the figure, the potential switch A will close automatically whenever the holding coil's circuit is complete. With switch P closed to the down position, the potential switch must be closed by hand after it has once opened, but coil A_c will hold the switch closed after it has been closed by hand.

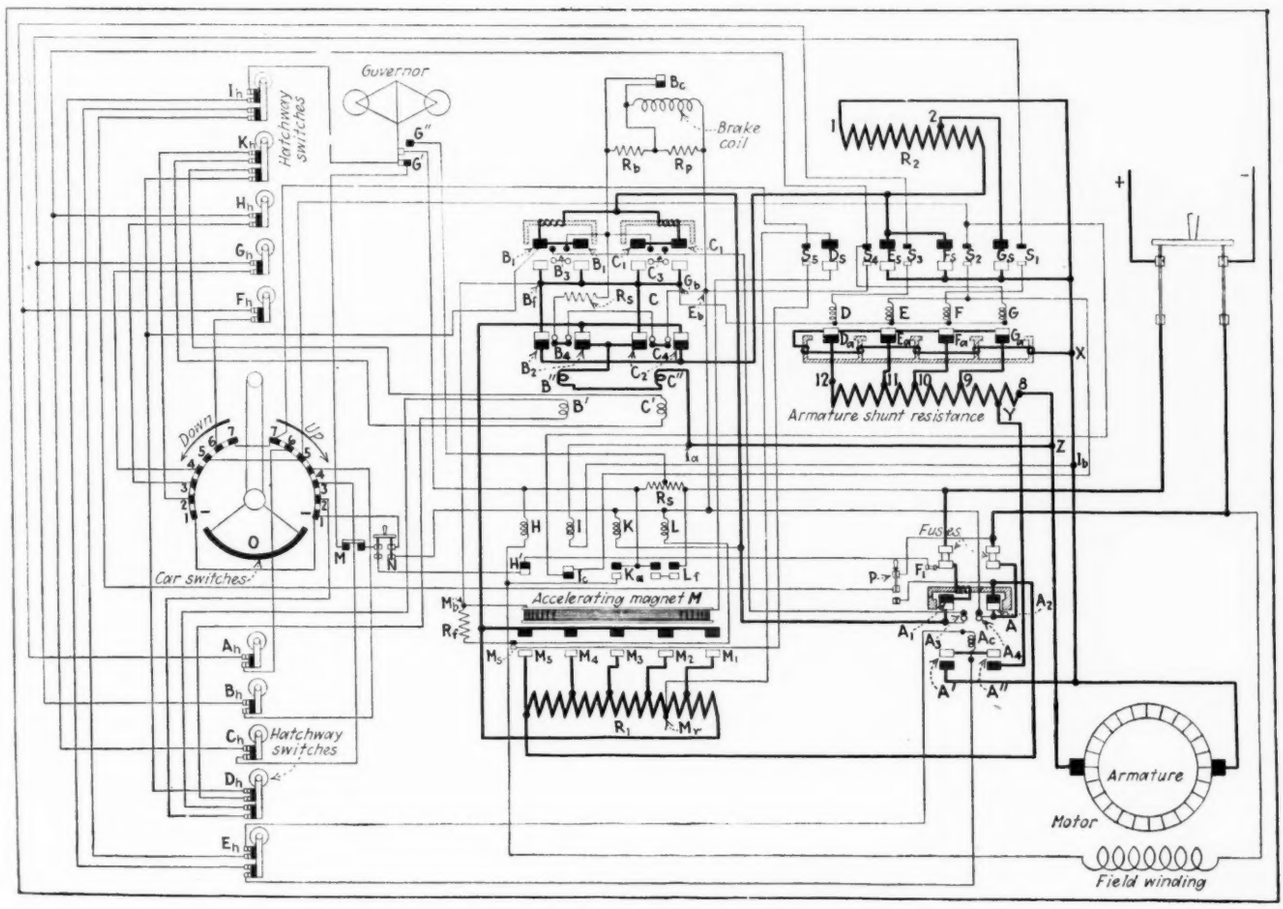


Fig. 3—Diagram of connections for the controller shown in Fig. 2

With the functions of the several magnets explained, the operation of the elevator by means of the car switch is as follows: Contacts 1 of the car switch are connected to the negative side of the line through the right-hand side of the emergency switch N, contact A_4 on the potential switch A to the negative side of the line. By moving the car-switch handle, for instance, in the direction of the down arrow, contacts 2, 3, 4, 5, 6 and 7 at the right are successively connected with contact 1, through segment O. The current's path may be traced from the positive side of the line to these contacts. Thus when contact O engages points 1 and 2, the path of the current will be from upper contact B_1 on reversing B, which connects to the positive side of the line, to the upper contacts of hatchway switch

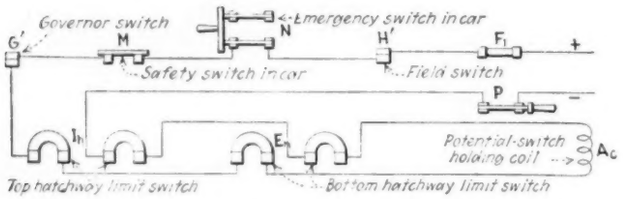


Fig. 4—Simplified diagram of potential-switch holding-coil circuit

D_h, shunt coil B' of reversing switch B, back to lower contacts of hatchway switch D_h, thence to contacts 2 and 1 on the car switch and to the negative side of the line. This energizes coil B' of switch B, which in operating makes the motor connections and lifts the brake shoes as previously described.

Further motion of the car switch brings contactor O in connection with point 3, and the circuit may be traced from the lower side of the upper contacts on the reversing switches B and C, which, upon the operation of either reversing switch, is in connection with the positive terminal. Starting from G_b, the circuit is through coil G to the upper side of S_3, to hatchway switch C_h, to 3 on the car switch and to the negative side of the line. The operation of switch G cuts out a step of the armature series starting resistance and inserts additional resistance in the armature shunt resistance, thereby speeding up the motor. In the same manner another increase occurs, when F is energized following the closing of point 4 by the car switch. This circuit is from G_b through coil F, contact S_1 hatchway switch B_h to 4 on the car switch and to the negative side of the line.

When the car switch makes contact at point 5, the connections result in providing a circuit to energize the coil of speed switch E, with a corresponding increase in the elevator speed. In this case the current does not go through any of the hatchway switches, but is direct from G_b through coil E and contact S_2 to 5 on the car switch and the negative side of the line.

Switch D is energized when the car switch is moved to make contact at point 6. The path of the current is through coil D, contact S_3, hatchway switch A_h and to 6 on the car switch. With the operation of switch D, the armature shunt resistance is opened, the accelerating magnet M is placed across the armature and a further acceleration occurs automatically through the gradual cutting out of series starting resistance R_1. Finally, with the car switch in the extreme position segment O makes contact with point 7, thus short-circuiting, in the manner already explained, fast- and slow-speed magnet L, which in dropping out inserts the resistance R_s in the shunt field and brings the motor to full speed. The current in this circuit also does not pass through the hatchway switches. Moving the car-switch handle in the direction of the up arrow, causes the magnets to act in the same manner, except that reversing switch C instead of B operates, causing the motor to run in the opposite direction. Also it will be seen that the current operating switches C, G, F and D in this case have their paths over the upper hatchway switches K_h, H_h, G_h and F_h.

In stopping at the floors, the car-switch handle is placed in the central position and the switches return to their off position in the reverse order from which they operated at starting. All elevators are provided with a device that brings the machine automatically to rest at the upper and lower terminal landings, independent of the operating device.

Control of Car at Terminal Landings

Suppose the elevator is going down and the operator retains the car switch in the full-speed down position; a cam on the car will, when near the bottom landing, successively open the lower group of the hatchway switches, with the following results: The breaking of the contacts of switch A_h drops magnet D. The opening of its contacts D_s and S results in the interrupting of the circuit through accelerating magnet M and inserting series starting resistance R_1. The short-circuit around the fast- and slow-speed magnet L is also opened by opening contacts M_s of the accelerating switch. Coil L again becomes energized and in attracting its armature makes contacts L_f and short-circuits the field resistance R_s. The making of contact D_a on switch D re-establishes the armature-shunt resistance 8 to 12, and the effect of the three operations slows down the motor. A little later the cam on the car opens the contacts of hatchway switch B_h, dropping switch F. Since the secondary contacts S_3 of this switch control switch E, under ordinary circumstances E will drop also. The result is that a portion of series starting resistance R_2 is added to the armature circuit, and the closing of the bottom contacts F_a and E_a short-circuits the portion between 10 and 12 of the armature-shunt resistance, thereby exercising a considerable slowing-down effect. The opening of the contacts of hatchway switch C_h drops switch G, with the result that with the breaking of its top contacts G_s, the entire series resistance is placed in the armature circuit, while the making of contact G_a reduces the armature shunt resistance to the portion between 8 and 9.

Opening the Reversing Switches

Further motion of the car causes the cam to engage hatchway switch D_h, which drops reversing switch B, breaking the armature circuit and leaving the motor subject to the dynamic-brake action due to the shunt across the armature with resistance R_2 in parallel with the section 8 to 9 of the armature shunt resistance. A little later, owing to the lag between the action of reversing switch and brake, the brake sets and the elevator, under ordinary circumstances, stops. However, should for some reason its motion continue, the opening of hatchway switch E_h occurs, followed by the opening of potential switch A, which in making its lower contacts A' and A'' reduces the armature shunt

resistance to the portion between 8 and Y, thereby exercising a heavy dynamic-braking effect.

If the elevator still continues to travel, it will engage the buffer under the car, relieving the traction of the cables on the motor sheave, thus stopping the car. It will be noticed that the hatchway switches, which slow down the elevator, namely, A_h, B_h and C_h at the bottom and F_h and G_h and H_h at the top, have double contacts, while those more important in stopping the motor, namely, D_h, E_h and K_h, I_h, at the bottom and the top of the hatchway respectively, break the circuit at four points.

The series-starting resistance is not proportioned to the maximum elevator load but to the average. That is, the two parts of the starting resistance in series will admit sufficient current to the motor to start an average load, but the maximum load can be started only when R_2 is cut out. For this reason the series starting resistance is split in two parts, of which one is under control of the operator. When the car reaches the terminal landing and opens the several hatchway switches, all the magnet switches successively drop into their off position, beyond the further control of the operator, and insert resistance in the armature circuit as outlined in the foregoing. This might stop the car with a heavy load before the top terminal landing is reached or before the bottom landing is reached with a light load in the car, if a means was not provided to prevent the motor from slowing down below a certain limit when the car successively engages the hatchway switches. If the car slows down below that limit, switch I, whose coil is energized by the armature's counter-electromotive force, drops out, permitting contacts I_c to close.

Stopping with a Light Load in the Down Direction

Consider the case of a light load on the motor, the operator retaining the master switch in the full-down position and the cam on the car striking the lower hatchway switches: First, the opening of hatchway switch A_h opens switch D, the opening of B_h opens F, and when the load is average, E also opens, owing to the opening of the secondary contact S_2. If the load is light the resulting slow-down due to the over-counterweight is too much, causing the load magnet I to drop out and close contact I_c. This results in bypassing contacts S_2 so that E will remain energized by a circuit from G_b through coil E to contact I_c, then to 5 on the car switch and to the negative side of the line. With a light load, therefore, E remains energized and its secondary contacts S_4 stay closed, which allows magnet G to receive current from G_b through coil G, secondary contact S_4 of switch E to E_b and to the negative side of the potential switch. Therefore when the cam on the car engages hatchway switch C_h in case of a light load in the down motion, switch G remains closed, so that, of the 4 switches D, E, F and G, D and F drop out and E and G stay closed. The result is that all the series starting resistance R_2 remains cut out, with the resistance of 8 to 10 shunted across the armature, whereby sufficient potential and current is supplied to the motor to prevent stalling or undue slowing down. In the up motion with a heavy load, the same operations would take place on approaching the top landing, as explained for the car with a light load approaching the bottom landing.

Tests of Dished Heads for Boilers

THE reported results of tests of dished heads for boilers made at the Materials Testing Laboratory of the Technischen Hochschule of Stuttgart, at the instance of the Wasserrohrkessel-Verbandes (Water-Tube Boiler Manufacturers' Association) are reviewed in brief by Dr. C. Bach in the *Zeitschrift des Vereines Deutscher Ingenieure* for March 21.

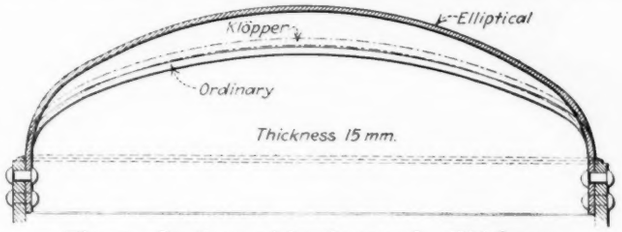


Fig. 1—Sections of heads tested. Thickness 15 mm. or 0.59 inch

Three types of head were tested—those of the usual form, those having an elliptical cross-section and those designed by an engineer by the name of Klöpper.

The three forms with the contours used for thicknesses of 15 mm. and 25 mm. are shown in Figs. 1 and 2 respectively.

The greatest distortion occurred in all cases at the heel or portion near the flange and manifested itself by the cracking off of the mill scale, an indication that the yield point of the material had been reached or passed.

The pressures under which this occurred are given for various thickness of material as follows:

Form	Thickness, Mm.	Thickness, In.	Pressure Ats.	Pressure Lb. per Sq. In
Elliptical	15.6	0.98	42.5	624.6
	19.6	0.77	64	940.6
	24.9	0.98	83+	1,220.1+
Klöpper	16.6	0.65	27.5	404.2
	25.7	1.01	43.5	639.3
Ordinary	14.9	0.59	11	161.7
	20.3	0.79	23.5	345.4
	24.4	0.96	28	411.5

Two samples of each type were tested and the pressure given is the average of the two. With the apparatus available it was impossible to increase the pressure to over 83 atmospheres, and in the case of the elliptical section of 24.9 mm. thickness the mill scale had not commenced to spring off at that pressure.

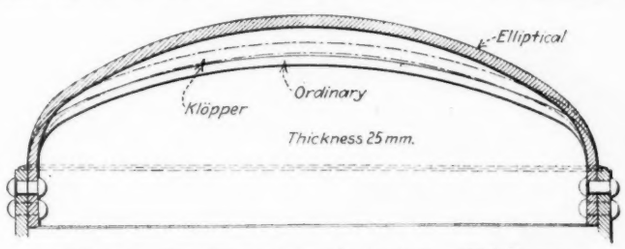


Fig. 2—Sections of heads tested. Thickness 25 mm. or 0.98 inch

In all cases the cracking off of the mill scale commenced at the heel of the flange. In the case of the usual and of the Klöpper types the distortion remained concentrated there. In the case of the elliptical section the scaling not only began later, but soon commenced to expand into wider zones.

In Fig. 3 the pressure under which the yield point occurs is plotted against the thickness of the material, showing not only that the elliptical section sustains a much greater pressure without distortion but the much steeper trend.

In Figs. 4 and 5 the distortion or movement at the center of the head under pressures of 12 and 24 at-

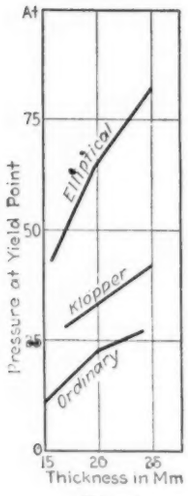


Fig. 3

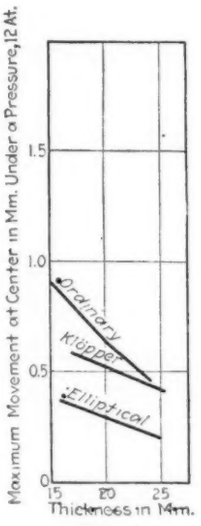


Fig. 4

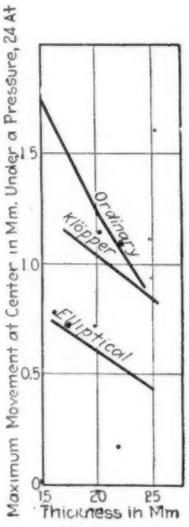


Fig. 5

mospheres respectively is plotted against the thickness of the material.

The diameter of the cylinder into which the heads were riveted was 1,300 mm. (51 in.) and the radius of the curves at the centers of the heads was of approximately the same length.

The heads were unstayed and of uniform section, without openings.

American Internally Fired Boiler

The publication of an article in the March 10 issue describing the internally fired boiler, invented by Oscar Brunler, a Belgian engineer, resulted in the receipt of a letter from James N. Seymour, consulting engineer, Newark, N. J., attaching a copy of the patent specifications for an internally fired boiler which he invented in 1916. The accompanying cross-section is redrawn from the patent specification, with explanatory notes.

The experiments upon which this invention is based were made by Mr. Seymour during 1914 and 1915, until they were halted by the war.

Referring to the drawing, which is based on the use of producer gas or other gas as fuel, separate pumps supply gas and air in the proper proportions to a fuel tank where the combustion mixture is stored under a pressure considerably exceeding that in the boiler. From this it passes through a back-fire screen to a rotary valve which admits the mixture in puffs to a submerged combustion chamber, the bottom of which is sealed by a check-valve disk.

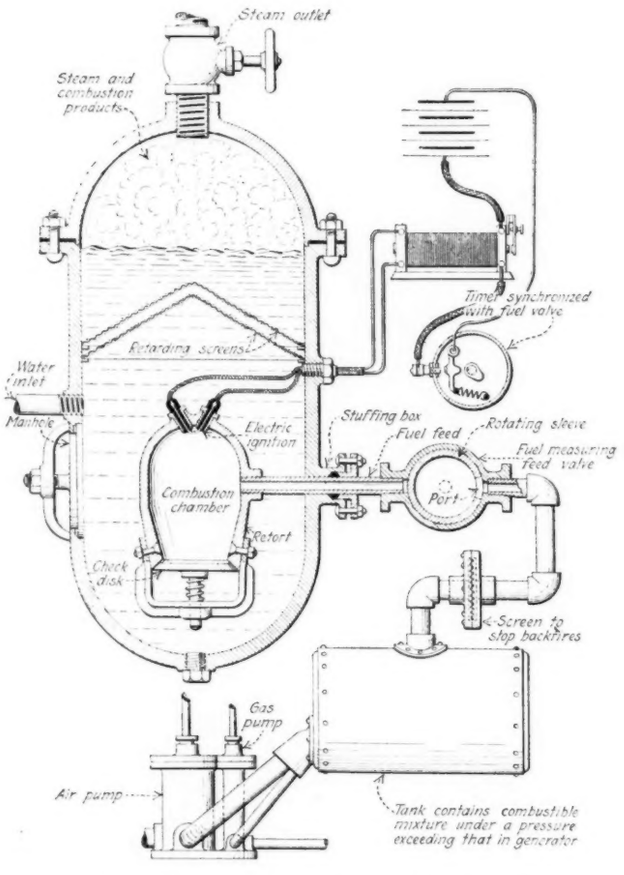
An electrically operated ignition system, whose timer is synchronized with the rotating valve, ignites each charge of mixture just after its admission to the combustion chamber. The pressure produced blows the products of combustion past the check disk, so that they bubble up through the water, giving up their heat at the same time. Retarding screens are provided to increase the period of contact. The mixture of gases and steam collected over the water may be led off to engines or other apparatus.

The patent specifications end with two claims, the first of which reads as follows:

First, a steam generator comprising a boiler shell, a retort within said boiler shell providing a combustion chamber opening a communication with the water in said boiler shell, a fuel-feed pipe communicating with said combustion chamber, a measuring valve, connected with said fuel feed pipe adapted to liberate gas charges into said combustion chamber under compression equal to or greater than the pressure of water in said boiler shell, a gas supply pressure tank connected with said measuring valve, means of feeding to and compressing gas and air within said pressure tank, and means for igniting gas charges within said combustion chamber

The second claim is the same as the first except that the following is added:

comprising spark terminals within said combustion chamber, an electric circuit connecting said spark terminals and a



Gas-air mixture is burned in submerged retort

timed circuit closing device for making and breaking said electric circuit to produce ignition sparks at said spark terminals.

While the drawing and description refer only to the combustion of gas, Mr. Seymour stated in his letter that it was possible and practical to burn pulverized coal in such a contrivance. For burning coal dust he found it necessary to have a long heavy cone-shaped combustion chamber open at the bottom. Hydrocarbons and mixtures of gas and air proved easiest to handle.

Increasing the Efficiency and Capacity of Existing Steam Power Plants

By ARCHER DAVIDSON
Engineer, Westinghouse Electric & Manufacturing Company

BY INSTALLING a relatively large turbine especially designed for the extraction of large quantities of steam, a power station not employing modern methods of heating the feed water may incorporate in new extensions a system of heating all the feed water in such a manner that the economy of the new power unit will be unusually favorable. Multiple-stage heaters would be used, not only for the feed water of the new turbine, but in addition, for the feed water supplied to the old part of the station, thus extending the regenerative cycle to a broader use than has usually been considered.

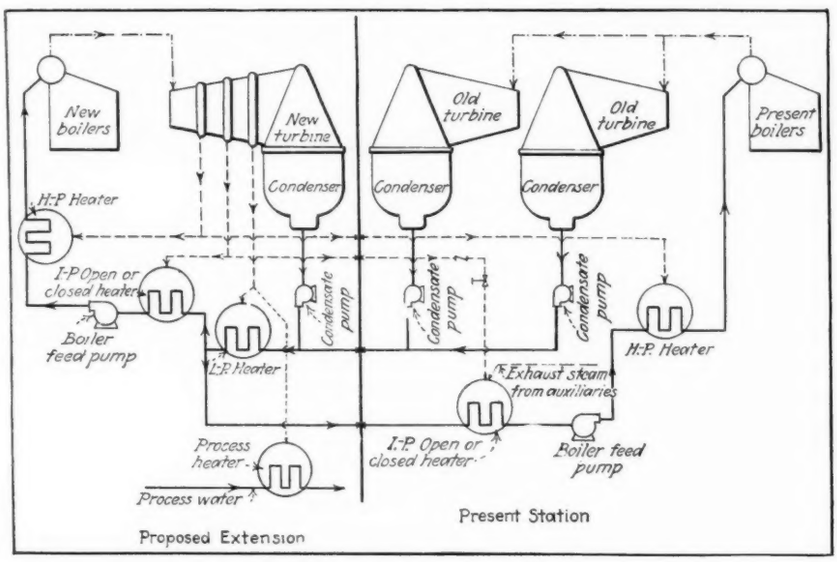


Fig. 1—Proposed method of heating feed water where surface condensers are used

Although the principal source of feed-water heating steam would be the new power unit, steam auxiliaries, house turbines, etc., may conveniently feed into the system. Centralization of feed-water heaters, which under certain circumstances may be desirable, would not be necessary, and the system lends itself to a high degree of flexibility and should in a large measure improve the station performance. The maximum benefit will be obtained by driving as many auxiliaries as possible with motors. The methods proposed may be used to heat boiler feed and also process water for industrial plants.

Fig. 1, on which unessential details are omitted, shows one arrangement of turbine and heaters for heating the feed water for the old part of a station as well as that for the new part with steam bled from the new turbine. Condensate from the surface condensers flows to a common header and into the low-pressure heater. After leaving the low-pressure heater, the flow of condensate divides, that part of the flow to the old part of the station going to the intermediate and high-pressure heaters separate from the intermediate- and high-pressure heaters in the new part of the station. This division of flow is made to permit the use of serviceable feed-water heaters located in the old part of the station and receiving exhaust steam from steam-driven auxiliaries that cannot conveniently be motorized. Additional steam required by such heaters is supplied from the new turbine. A heater for process water is shown connected in parallel with the low-pressure boiler-feed heater. Raw water may be passed through this heater.

There are plants using jet condensers where water or other conditions make surface condensers impracticable. Usually, such plants obtain their boiler-feed water from sources other than the water circulated through the condensers. Hence the initial temperature of this boiler-feed supply is usually

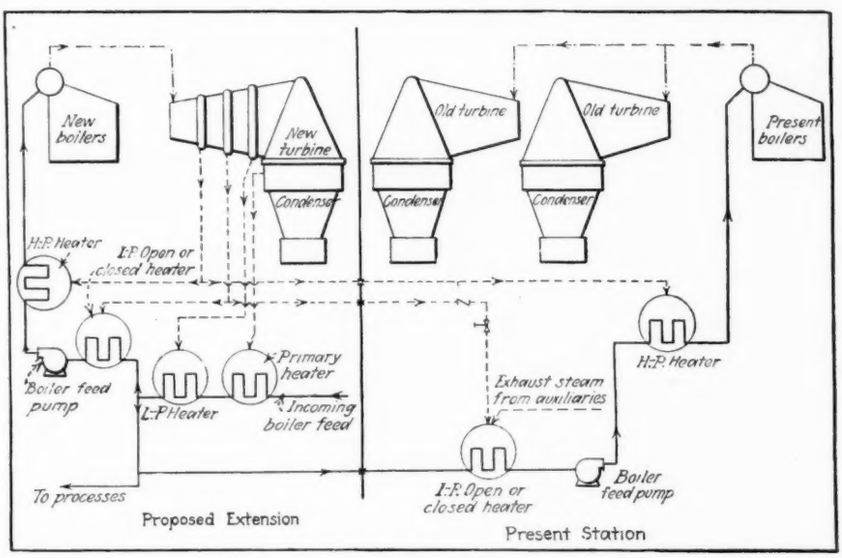


Fig. 2—Proposed method of heating feed water where jet condensers are used

much lower than the temperature corresponding to the vacua existing in the jet condensers. In several cases investigated the difference in temperature was approximately 30 deg. F. for all seasons. Fig. 2 shows an arrangement similar to that of Fig. 1, except that the turbines are provided with jet condensers, the feed comes from an external source, and an additional heater taking steam from a point between the exhaust of the main turbine and condenser is used. All steam supplied this heater is a total gain because it has done the maximum possible work in passing through the turbine. One pipe branch for heated process water is shown in the illustration.

Turbine Efficiency Obtainable

With respect to the efficiency to be obtained on the turbine of the extension of the plant, the author recently investigated a plant having efficient existing units totaling 90,000 kw., served by jet condensers and operating on steam at 200 lb. gage and 500 deg. F. total temperature. This plant was to be connected with a contemplated new unit of 30,000 kw., operating on 350 lb. gage and 636 deg. F. total temperature. It was proposed to use a primary heater and three-stage turbine extraction heating of all boiler feed to approximately 300 deg. No heated process water for manufacturing purposes was here considered. The installation of the high-pressure heaters in the old plant and the motorizing of a number of previously steam-driven auxiliaries was found to be neither difficult nor expensive.

With 1,250,000 lb. of 60-deg. boiler feed entering the station, which corresponds to approximately 90,000 kw. on the older units and 30,000 kw. on the new unit, giving a combined station load of 120,000 kw., the steam through the throttle of the new unit was approximately 425,500 lb. per hour, and only 152,700 lb. per hour of this steam, it was estimated, would go into the condenser. The remainder, or 272,800 lb., was taken out by the heaters and the condensate thereof delivered to the feed for the boilers. This condensate materially reduced the cost of purchased boiler-feed water. The steam consumption rate based on the steam reaching the condenser of the new unit was 5.09 pounds per kilowatt-hour.

As to feed-water piping complications these will vary for each plant. If it is found objectionable in large plants to combine the entire boiler feed into one pipe, this objection may be removed by providing two or more heaters for each bleed point of the new unit so that the feed may be separated into as many individual systems as may be desired. The location and arrangement of the boiler-feed pumps and the boiler-feed piping will determine the location of the high-pressure heaters. The intermediate-pressure heaters may be a considerable distance from the turbine without serious loss, but the low-pressure heaters should be as close to the turbine as possible to avoid pressure losses and expensive piping between the turbine and the heaters. The condensate from the heaters will be handled the same as in modern stations provided with heaters for the progressive heating of boiler feed.

No complicated means of regulation of the steam flow to the heaters are required. Best economy is obtained by keeping the new unit fully loaded so as to maintain a nearly constant pressure at the bled points, in consequence of which the water is heated to a constant temperature.

Corrosion Without Oxygen

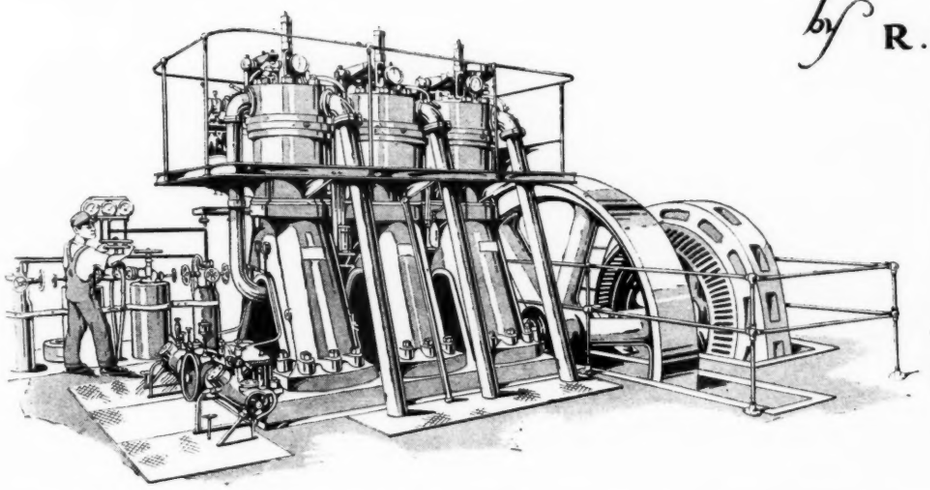
At the recent corrosion symposium of the American Chemical Society in Baltimore, Messrs. Shipley, McHaffie & Clare brought out an interesting point in connection with corrosion. They stated that in the absence of dissolved oxygen the corrosion rate of iron is proportional to the hydrogen-ion concentration down to a "*pH* value" of 9.4, where hydrogen evolution and solution of iron cease. For those not familiar with chemical terminology this may require further elucidation. The word "acid" has a fairly definite meaning to the average man, signifying that which gives a substance a sour taste and causes it to eat away metals and other substances. Chemists have desired some more definite way of measuring the strength of the acid effect, or the "acidity." They have discovered that the quantity of hydrogen ions—that is the quantity of electrically charged hydrogen atoms in a given volume of the solution—was a very good measure of its acidity. Therefore chemists have come to talk of "hydrogen-ion concentration." The weight of these ions is an extremely small fraction of the weight of the fluid. To avoid writing decimals with many ciphers after the decimal point, the chemists have invented a term which they call the "*pH* value." This value is not the hydrogen-ion concentration, but is related to it in a simple manner. As a matter of fact the hydrogen-ion concentration for any given value of *pH* is equal to a fraction whose numerator is 1 and whose denominator is 1 followed by a number of ciphers equal to the *pH* value. For example, a *pH* value of 6 represents a concentration of one-millionth of a gram of hydrogen per liter of solution (one gram per liter represents about one part per thousand by weight). To take another example, a *pH* value of 9 represents a concentration of one-billionth gram of hydrogen ions per liter of solution.

It should be particularly noted that a high *pH* value does not mean a high acidity, but the reverse. A *pH* value of 6 represents a concentration one thousand times as great as a value of 9. Returning to the original statement of the authors, it means that strong acid will eat iron, even without the presence of oxygen. As the acid is progressively diluted, this action can be continued until the *pH* value has risen to the 9.4. For weaker acids than this—that is, for *pH* values higher than 9.4—there is no corrosion unless oxygen is present.

That the engineering industries of Great Britain have reached an economic crisis is clearly evident from a report recently issued by the British Engineers' Association, entitled "Present Conditions and Future Prospects of the Engineering Industry." This report is an attempt to face what appears to be a gloomy situation in a straightforward manner. The upshot of the whole matter seems to be that, due to many causes, but chiefly the high cost of production, British manufacturers of engineering products are, on the whole, unable to meet foreign competition and leave any margin of profit whatever. The report draws the reasonable conclusion: "In the light of these facts it is impossible to escape the conclusion that our only hope lies in reduced cost of production and distribution, but its fulfillment is dependent on the willing co-operation of capital, administration and labor."

OPERATION OF DIESEL ENGINES

by R. Hildebrand *



Air Starting Valves and Their Care

DIESEL engines are started with compressed air which is admitted to the working cylinders by starting valves. Some manufacturers equip only one of the cylinders with a starting valve, while others apply starting air to several cylinders.

The air pressure needed to start the engine will depend on its condition and on the number of cylinders equipped with starting valves. Engines applying starting air to one cylinder only and engines in poor condition with leaky pistons, valves and gaskets, need higher starting air pressures than engines in good condition and equipped with several starting valves. However, it is desirable to use starting air of no higher pressure than necessary to make a successful start.

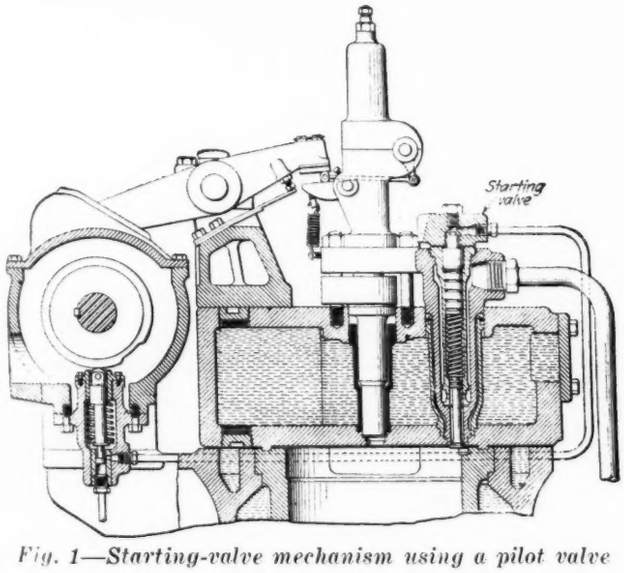


Fig. 1—Starting-valve mechanism using a pilot valve

We may distinguish two different types of starting valves, one being opened by a cam-operated lever, the other by compressed air. The closing of the valves is in all cases alike, being accomplished by a spring. Fig. 2 shows a lever-operated and Fig. 1 an air-actuated starting valve, the air acting upon a small piston fastened to the end of starting valve stem, and in Fig. 3 is shown a design where a mechanically operated air-control valve is used in connection with a lever-actuated starting valve.

Most types of starting valves give satisfaction. The air actuated valve has the advantage of avoiding a lever or rocker arm and of being located where it is most accessible, generally at the back of the cylinder head. Particularly in a four-stroke-cycle engine where four rocker arms for inlet, exhaust, fuel and starting-air valves are needed, if a lever-operated starting valve is used, the valve becomes quite inaccessible as it is located below the rocker arms. On the other hand, the lever-operated valve eliminates the timing or pilot valve which admits the compressed air needed to open the air-actuated starting valve.

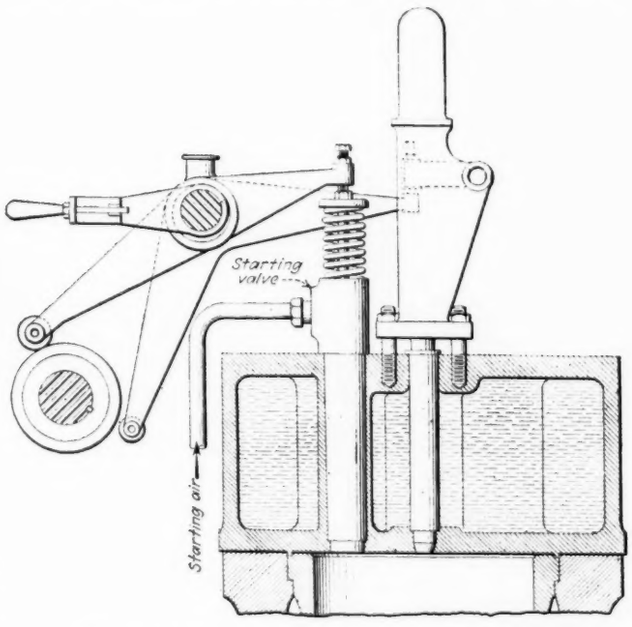


Fig. 2—Air-starting valve opened by a lever

While the designs of the starting valves differ to a great extent in the different types of engines, they all need the same care. The starting valve has a tendency to stick inasmuch as the air, being damp, has a cor-

*Chief Engineer, Diesel Division, Fulton Iron Works Co.

rosive effect on the valve and as the starting valve is used only during the moment of starting.

The valve should be lubricated before the engine is started. Each manufacturer should and generally does provide a convenient means to lubricate the valve. Having been lubricated, the valve should be tried by forcing it open by means of a bar, to see whether it moves freely and closes readily.

In case a starting valve sticks and an application of lubricating oil does not make it move freely, it should be taken apart, inspected and cleaned. To heavily dose a sticking starting valve with kerosene, in order to make it move freely, is objectionable, as this may cause an explosion in the starting valve, air line or

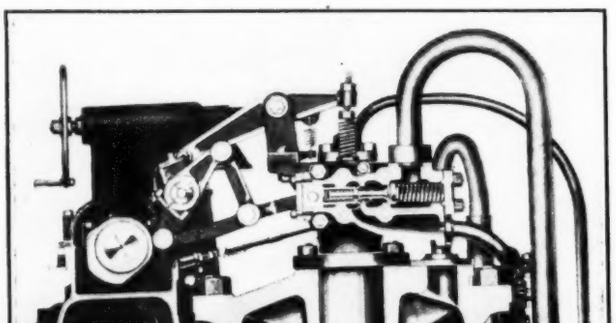


Fig. 3—Starting arrangement used on a two-stroke-cycle engine

starting-air bottle. A hissing noise noticed when the inlet valve opens indicates that the starting valve is sticking. If the engineer is fortunate enough to experience no serious accident on account of the sticking valve, he should by all means take the faulty starting valve apart when the engine is shut down.

An engineer should understand the danger that a sticking starting valve involves. If a starting valve sticks and remains open till the first part of the compression stroke, the compression begins with a pressure corresponding to the starting air instead of atmospheric air. Consequently, the pressure reached at the end of the compression stroke may be so high that it wrecks the engine. Therefore the engineer should not attempt to start the engine unless he has tested the starting valves and knows that they function properly.

The starting valves should be kept tight. Leaky starting valves not only cause a loss of starting air during the starting period, but they also diminish the compression inside of the working cylinder and permit products of combustion to enter the starting valve as well as the starting air line, while the engine is in operation. If this happens, carbon will collect inside the starting valve, causing it to become gummed and uncertain in operation.

The engineer is advised to test the starting valves from time to time to determine whether they are tight. Turn the crank in the upper dead-center position. Turn on the starting air and listen for the air to whistle out of the open indicator cock or valves.

The engineer should observe the pressure in the starting air bottles before and after starting and become familiar with the amount of starting air the engine requires for starting. He will observe that the engine in good condition needs a small amount of starting air, while the engine with leaky valves, gaskets and piston rings, requires a greater amount. Thus he can judge whether the engine needs looking after from the amount of starting air and pressure needed for starting the engine. A sudden increase in the usual amount of starting air consumed is always a sign that something is wrong with the engine and the engineer will do well to inspect it before starting it up again.

After a starting valve has been inspected and replaced, good judgment should be exercised when tightening up the nuts holding the valve in the cylinder head. Be especially careful with those types where the valve is guided in the cage and in the bonnet. If the bonnet is slightly kinked by uneven tightening of the nuts, the valve will stick and bind. Never permit the slightest irregularity in the functioning of the starting valves. If there seems to be anything wrong with one of the valves, be sure to take it apart. Do not run the risk of using a starting valve that is not in perfect working order, as it may result in serious difficulties.

Influence of Human Element on the Operation of Oil-Engine Units*

By A. D. Newell

The purchaser of an oil engine is correct in assuming that such engines present no serious problems of operation if properly handled. The mechanical problems involved are not so difficult to understand that any man with good common sense cannot master them as quickly as he could the problems of a steam plant if he had no previous knowledge of either type of machinery. There is no mystery involved, and one does not need a college professor, a mechanical engineer, a master mechanic and an old Scotch steam engineer combined in one staff to handle a plant of large size successfully. He will be badly mistaken, however, if he thinks that when he gets his plant ready to start he can pick up a man off the street and obtain good results simply because the new employee knows how to use a monkey wrench or perhaps a slash bar.

Men whom I know are operating oil-engine units of over five hundred horsepower most successfully, are a strange combination. One was a successful chief engineer of a large steamship, another a machine-shop foreman, a third started out as a laborer in a roundhouse near Pittsburgh, while still another did his most notable deeds as a truck driver in France during the war. Quite a number are foreigners who have gone through the training required of all engineers in Europe, which is no doubt a more thorough training than the average engineer receives in America. However, they do not excel the American who takes to the work and learns to think in terms of oil engines.

It appears to me that the difference between a good engine and a poor one is sometimes the difference between having a capable operator in charge and having one who is at best rather indifferent. This is not charging the unsatisfactory performance of freak engines to indifferent operation. But surely, a very poor engine in the hands of an incapable engineer will make a wretched showing.

*Extract of a paper read before the National Association of Stationary Engineers, Philadelphia, Pa., April 25.

Efficient Units for Small Plants

THE economies possible in the large generating plants have been so widely discussed that the small plant has been more or less ignored. While a pound of coal per kilowatt-hour output is a possibility in a superpower plant, by proper design a plant of two hundred horsepower can be built to perform the same duty with almost the same economy. Steam consumptions as low as six pounds of steam per indicated horsepower-hour have been obtained in compound engines of special design operating at high pressure, and efficiencies of eighty per cent are by no means impossible even with small boilers. In other words, through high pressures and superheats the small plant is placed on more or less of a parity with the large station. Such steam records are more than mere test results, for steadily the efficiency of the reciprocating engine has mounted upward until a unaflow has shown a steam consumption of about fourteen pounds per indicated horsepower when operating against a back pressure of two pounds gage, and with an initial pressure of two hundred pounds. As a consequence it is possible to obtain good economy during the summer with non-condensing operation, and during the winter the cost becomes very small owing to the use of the exhaust steam for heating.

All the possible improvements need not be carried out simultaneously. New efficient prime movers may be installed, and when the savings made cover their costs, high-pressure boilers and other apparatus can replace the old machinery. In this way the capital investment is merely the initial payment for the prime movers.

Dished Heads for Boilers

ON ANOTHER page are given the results of tests of dished or bumped heads of different forms and thickness of material reported by Dr. C. Bach, whose research work and contributions to the literature of the subject are well known.

In all cases the type in which the curvature changes gradually from the point where it leaves the straight flange that sets into the shell, turns with a long radius and merges itself in the contour of the central portion of the head, showed less distortion than the others.

It is not, however, sufficiently descriptive to designate this type as "elliptical." A head with a very flat elliptical section would probably be as weak in the heel as the weaker specimens of the test. An ellipse, however flat, is tangent to the axis at the end, but it is the form with a gradual departure from the tangent at the flange and a gradual turning through the right angle to the apex of the dome that has, as would be expected, demonstrated its superiority. If the ellipse is the correct curve or section, that ellipse should be the stronger which has the largest ratio of minor to major axis, the strongest form being when this ratio becomes unity and the ellipse becomes a circle or the dished head a hemisphere.

The critical point is the abruptness of the curvature at the flange where the head is riveted into the shell. This is where fracture occurs in practice and where the tests located the distortion. The construction code of the Boiler Code Committee of the American Society of Mechanical Engineers prescribes (p. 197) that the corner radius of an unstayed dished head measured on the concave side shall not be less than one and a half or more than four inches, and within these limits shall not be less than three per cent of the radius to which the head is dished. The restriction to four inches has been decided to be unnecessary and has been withdrawn by interpretation.

The Cost of Ownership

THERE are 8,760 hours in a year. If one deposited a single cent each hour, day and night, he would have $87.60 at the end of the year. A single mill deposited each hour would build up to $8.76 in the same period. Two mills per hour would make $17.52. This latter figure is not far from the yearly charge for interest, depreciation, taxes and maintenance on the average $100 invested in power plants, although the actual figure is generally somewhat lower. For the sake of simplicity assume this figure to be exact. Then each $100 invested costs the owner two mills per hour. If his plant cost $100 per kilowatt to build, the mere ownership of each kilowatt of capacity costs him two mills per hour whether he uses it or not.

The average central-station yearly output is in the neighborhood of one-third of the plant capacity. In this case the ownership costs of two mills per hour per $100 per kilowatt invested must be borne by one-third of a kilowatt-hour, bringing the ownership cost to six mills per kilowatt-hour.

Too little attention is given to this factor in comparing the performance of stations. It is not uncommon for two central stations operating under somewhat similar conditions, and of similar size and date of construction, to differ by as much as $100 per kilowatt in construction cost. With fixed charges and plant load factor as assumed, the more expensive plant would have to show a coal saving of six mills per kilowatt-hour to justify itself. With five dollar coal this would require a coal saving of 2.4 lb. per kilowatt-hour, a figure exceeding the total coal consumption per kilowatt-hour of most of the well-designed cheaper stations.

Perhaps the assumptions have been unduly hard on the expensive plant. To remedy this, run the load factor up to 50 per cent, increase the coal price to eight dollars per ton, and cut the fixed charges to twelve per cent. The more expensive plant must still show a saving of 0.7 lb. coal per kilowatt-hour to justify its extra cost. How many such plants can do it?

Preventing Corrosion When Placing a New Station in Service

THAT load must be carried at the earliest possible moment is a requirement of many stations or plant additions when placed in operation. In racing against time, engineers frequently must choose between following the best practice with respect to routine tests, adjustments, etc., or compromising in order to lessen delay. The solution depends upon relative expense, risk, future conditions, etc., so that personal judgment which cannot well be proved by figures must ordinarily determine each case.

Corrosion is one of the many risks that should not be lost sight of. With the application of higher pressures has come a deeper realization of the need for removing free oxygen from boiler feed water. Also, examples are not lacking where corrosion has been particularly active during the starting-up period of a plant. In one instance practically every known oxide and hydroxide of iron was found plentifully distributed through a large prime mover. In another the violence of corrosion had been such as to affect balance-weight fastenings.

While steam turbine blades may be comparatively well protected by virtue of their composition against such attack, they may nevertheless be exposed to wear by the passage of corrosion products. As dirt or foreign material, the various iron oxides are objectionable in other locations. While cleanliness is overwhelmingly important largely on account of the damage possible to prime movers, it should be realized that the deaëration of boiler feed water is also equally essential for similar considerations, and should not be neglected when preparing for regular service.

The Operator an Important Factor in Hydro Plants

IN MODERN hydro-electric plants efficiencies have been obtained that are about as high as it is economically possible to make them. Large turbines of the reaction type, designed for moderate speeds, have approached ninety-four per cent maximum and developed an efficiency of over ninety per cent between about fifty per cent and over full load. Waterwheel generators have shown efficiencies of ninety-eight per cent and over. Large transformers used to step the generator voltage up for transmission, have the remarkably high efficiency of over ninety-nine per cent. In one case on record an over-all efficiency of over eighty-eight per cent is obtained for the entire development. This includes all losses from where the water is taken out of the river to the tailrace, and the losses between the turbine and the switchboard.

Even though these efficiencies are obtained with the largest units, designed for the highest economical efficiency, they are nevertheless remarkable and show that the manufacturer and the designer have in this respect attained an enviable record. With hydraulic turbines of moderate size the efficiency is also high, approaching closely to ninety per cent and frequently exceeding this value.

In a water-power plant, as in a steam station, much depends upon the operator as to what the over-all efficiency of the plant will be. In the former there is probably a greater variety of conditions to be contended with than in the latter. During the high-water season, when there is an excess of water, efficiency may be of secondary consideration, and the thing of chief importance is to get the maximum kilowatt-hours out of the plant. As soon as the plant can use all the available water, the conditions are reversed and it becomes a case of operating the station to obtain the highest efficiency, and such operation requires eternal vigilance on the part of the operator.

Outside of leakage at the runner seals, the other water losses are largely under the control of the operator when there is not an excess of water. A common source of loss in water-power plants is the leakage through the turbine gates when the unit is shut down. When the equipment is new, this loss may be less than one per cent of the full-load water taken by the turbine. Owing to wear and other causes this leakage after a few years' operation may amount to five or ten per cent. Such losses can be largely eliminated by closing the penstock valves or headgates when the turbine is shut down.

The output of the plant for a given amount of water is a function of the head, therefore it is necessary to maintain the head as high as possible consistent with other conditions, and it is a matter of proper loading of the plant. Another feature of operation that is under the control of the operator is the loading of the units to obtain the highest efficiency. This requires careful study based on individual turbine efficiency from which a loading schedule is worked out. Lacking test data on the turbines, the next best is the efficiency curves supplied by the manufacturers. Every plant will present problems peculiar to its own condition, but in most cases these are such that the resourcefulness and judgment of the operator is an important factor in the kilowatt-hours delivered to the switchboard.

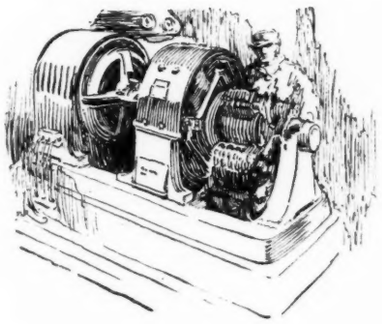
A New Branch of Engineering

THE widespread use of purchased energy in factories apparently is bringing into existence a new line of activity for the engineer. In most states the Public Service Commission permits rates such that a return of about eight per cent is allowed on the public utility's investment. Anything that increases the cost of putting the energy on the consumer's premises is reflected in higher electric bills. While the practice is as yet in its infancy, there is a tendency among large consumers in certain sections toward the employment of an engineer by the customers whose duty it is to see that the central station leaves no stone unturned to prevent increased rates.

In one instance several large consumers, after establishing before the Commission what a fair rate should be, have employed an engineer who keeps in close touch with the generating plant and does not hesitate to call attention to defects in operating procedure. Since the contracts cover a coal clause, especial attention is given to the cost of fuel and whenever the price paid is above the market price the consumers immediately offer to supply the fuel needed. In this way any likelihood of the coal clause charge becoming burdensome is removed.

Originally, the Public Service Commissions in most of the states were formed to act as the representatives of the consumers, but as these bodies have more and more assumed a judicial character, it would seem that a new profession may be created, *consumer engineering*.

Practical Ideas from Practical Men



WITH a view to stimulating engineers into the habit of recording for the benefit of brother engineers, unusual occurrences, how these were met and other practical expedients adopted in the operation of their plants, Power has decided to award two cash prizes each month during 1925. One of $25 for the best and another of $15 for the second best practical letter on plant operation or practical kinks received during the month. This is in addition to payment for the contribution at space rates. The winners for April will be announced next month.

Power is pleased to announce the awards of the judges for the first and second prize contributions received during March for this department in accordance with the terms of the contest as stated above.

The first prize of $25 goes to Richard H. Morris, of Clarkdale, Ariz., for his article on "Refinishing a Large Crankpin in Position," in the April 14 issue.

The second prize of $15 goes to Hugh Humphreys, of Grand Rapids, Mich., for his article on "Construction of Loose Pulley Having Large Oiling and Wearing Surfaces," in the April 7 issue.

The judges were: (Chairman) D. L. Fagnan, formerly refrigerating engineer and more recently associated with the Smoot Engineering Corp., New York City; Willis Lawrence, mechanical engineer, Interborough Rapid Transit Co., New York City and Norman N. King, chief engineer, Singer Bldg., New York City.

Home-Made Boiler Front Polish

From time to time articles appear in the engineering magazines describing a paint that is recommended for the front and rear ends of boilers. I consider the painting of boilers the hardest test that paint can be put to, the reason being that some parts of the steel and cast iron are only warm, while other parts are heated to a high temperature.

When paint is applied to the metal parts of any boiler, the boiler should be out of service. When it goes back into service again, the parts get heated up to different temperatures, and any paint I have ever tried will blister and peel off in patches, which leaves the finish in a bad condition, and the more paint that is applied the worse it gets.

For a number of years we have used graphite plumbago mixed with water to a consistency of paint. It is applied with a paint brush and allowed to dry, then polished by using waste or a polishing cloth. It requires but little rubbing, takes on a smooth finish and gives a blue color. This finish will stand indefinitely, and all that it requires is a dusting.

Before applying the graphite plumbago, all the old paint must be scraped off. THOMAS PASCOE.

Norway, Mich.

Using Sulphur Tapers To Locate Ammonia Leaks

There is a practice, common among refrigerating engineers, that is as dangerous as it is common. I refer to the practice of locating leaks around ammonia systems by the use of a sulphur match or taper. Personal experience has shown that the practice is about on the same level with that of trying to locate illuminating gas leaks with a lantern.

Several years ago I had charge of a plant containing a 100-ton, horizontal, inclosed, high-speed machine direct connected to a synchronous motor that had given considerable trouble with leakage at the crank-end cylinder-head flange. The load on the machine varied from a 25 per cent overload to practically no load, and we had considerable trouble in keeping our rod packing tight enough to hold wet gas. Between the gasket and the rod, we were kept guessing as to which was leaking when a leak was smelt.

One day a leak persisted even after the cylinder-head studs were pulled up and the packing tightened, a sulphur taper was lighted and the hunt for the location of the leak started. When the taper was moved around the cylinder head joint, a small explosion took place, quickly followed by a more severe one. A sheet of flame seemed to follow the rod back and forth for several seconds and then an explosion took place in the crankcase that stripped the threads on the machine screws holding the crankcase cover to the frame. The main switch was tripped by hand, and after the machine was stopped an examination was made to find out what was the extent of the damage.

If anyone had been passing the crank end of the machine at the time of the accident, or if the crankcase cover had hooked under the crank instead of being thrown clear of the moving parts, there would have been a serious accident. As a result of this experience we use litmus paper in locating leaks.

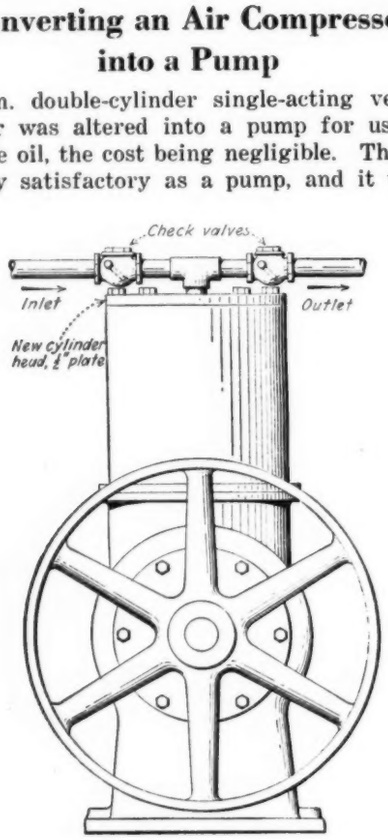
As this machine had been in continuous service for nearly one hundred hours at the time of the trouble and the oil in the crankcase was very warm, I have always been of the belief that the breaking down of the oil and the freezing of hydrocarbons in the form of oily vapors was a contributory cause. D. L. CORN.

Bridgeport, Conn.

[Experiments indicate that ammonia is not explosive in the presence of a lighted match or taper. The explosions were no doubt due to overheating of the oil and its ignition by the hot piston rod.—Editor.]

Converting an Air Compressor into a Pump

A 6x6-in. double-cylinder single-acting vertical air compressor was altered into a pump for use in handling crude oil, the cost being negligible. The machine was wholly satisfactory as a pump, and it was in no way rendered unserviceable for being restored to future work again as an air compressor.



Details of alterations required to change air compressor to pump

To make the change, the regular cylinder head was discarded and new heads made of ½-in. steel plate, fitting each cylinder independently. Each head was then drilled and tapped to take a 2-in. pipe nipple, tee and check valves as shown. No other changes were needed. When used as an oil pump, the apparatus was run at about 40 r.p.m. and required less than five horsepower.

Many gas and steam engines can be easily transformed into pumps if desired, and with some types of four-cylinder gas engines it is possible to use two cylinders for power while the other two are arranged to serve as a pump. It should be remembered, however, that while pumps made from engines will serve for oil and oily water, they are not suitable for liquids of a character that will produce cylinder wear and scoring.

Casmalia, Calif. V. A. LYMAN.

Collector Rings on Synchronous Motors Wear Unevenly

A while ago we noticed that the collector rings on our synchronous motor-generator sets were wearing unevenly. There are two of these sets, one of 1,150-kva. and the other of 550-kva. rating, with 125-volt direct-current field excitation. In each machine the greatest wear is always on the ring connected to the negative side of the exciter busbars.

At first it was supposed that this greater wear came from a difference in the abrasive quality that might be in the brushes, as the spring tension was about the same on all of them. For the purpose of experiment the hard carbon brushes of the worn ring of the larger machine were replaced with soft graphite ones, the brushes on the smaller machine remaining as they were. The collector rings were ground smooth and the effect of the softener brushes watched. After a few months' run it was found that the wearing of the collector ring using the graphite brushes was about the same as ever. The brushes were a good fit and showed no trace of sparking that might account for the wear.

An examination was then made, which seems to show this wearing to be mostly due to the action of the current flowing out of the collector ring into the brush. The surface of this brush was found to be coated with a heavy copper scale, while the surface of the other one was perfectly clean. A chemical analysis was made of the dust collected from the brush-holders of the smaller unit, as the brushes on this machine were of the same quality of carbon. This analysis showed a copper content of 32 per cent for the sample taken from the negative connected brush-holder and 14 per cent for the positive. These values do not, of course, show the proportionate wear on the collector rings, but they do show that the ring out of which the current flows can be expected to wear out the faster.

To equalize this difference in wear on the rings, the direction of the field current flowing through them was reversed, which should cause the other collector ring to wear this time. Otherwise, in a few years we could expect to have each machine with one worn-out ring and the other almost as good as new.

From this current effect on collector rings, it has occurred to me that the same action must take place on commutators as well, and it may have more to do with causing the uneven wear across their face than abrasion has, which is generally supposed to be the cause.

R. ELDERKIN,
Nova Scotia Tramways & Power Co., Ltd.
Halifax, N. S., Canada.

Fuel Economy in Small Plants

In these days of high coal prices we hear much of fuel economy. The large plants are reasonably efficient, but the small plant of today has a great opportunity to save fuel. By small plants is meant those of 5,000 hp. or less.

In my experience I have found a large proportion of boiler plants in this class operating at efficiencies of 55 per cent and under. Taking a furnace and boiler operating at 55 per cent efficiency, we have an avoidable loss of about 33 per cent and a flue-gas analysis would show us a CO_2 of around 4 per cent, meaning an excess air supply of 417 per cent. If we should raise the CO_2 to 12 per cent, there would be a saving of about $370 on every thousand dollars spent for coal.

Unfortunately, the average man in these plants is without the essential instruments found in a modern well-operated boiler plant, such as a CO_2 machine, steam-flow meter, coal scales, stack thermometer and draft gages, and he does not realize the losses that exist.

The furnace should be designed for the fuel to be burned, consideration being given to space necessary to complete combustion; a fair average is 0.25 cu.ft. per sq.ft. of heating surface. In addition, the furnace should be adapted to the boiler with which it is to be

used, and the draft should be controlled by efficient dampers.

I recall a plant in southern Indiana having boilers of 30,000 sq.ft. total heating surface which was operating at very poor efficiency. The chief engineer seemed to be satisfied as long as the plant was running. A water power was run in connection, and one day in winter the dam failed. The steam plant could not carry the extra load, and a combustion engineer was called in. A test showed they had an average of 5 per cent CO_2 and a 10 per cent loss of coal in the ashpit. The avoidable loss was from $150 to $175 a day, and after the combustion engineer was through, four boilers were able to do the work that previously required six to take care of.

In another instance, in a plant having two 1,500-sq.ft. tubular boilers, it was found that the combustion chambers were filled with soot and ash up to within one foot of boiler shells from bridge wall to the rear. There are any number of boiler plants in just this condition, and if the owners only knew what losses this meant, there would be a change in the engineeering force.

When checking up the draft, one should remember that it is easy to get too much draft. The following figures give an idea as to the amount of coal burned per square foot of grate surface in one plant:

Lb. per sq. ft....	10	15	20	25	30	35	40	45	50
Draft over fire..	0.07	0.12	0.18	0.23	0.30	0.37	0.45	0.52	0.60

These figures are not exact, but are an average of the results. In many small plants the breeching causes a great loss in draft. The breechings are often long and have several turns; each 90-deg. turn offsets 10 feet in stack height, and each foot in length offsets ½ foot of stack height.

L. B. SHIELDS.

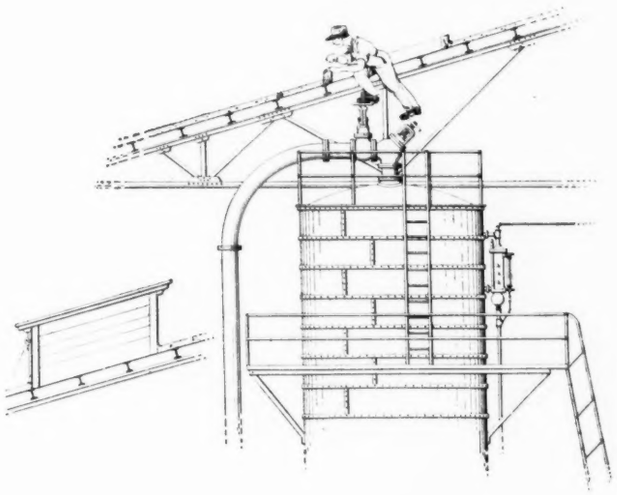
Chicago, Ill.

Eliminating Dangerous Conditions in the Power Plant

A short time ago a 4,000-sq.ft. vertical boiler in a battery of three was taken off the line for replacing a number of tubes. Directly above each of the boilers there is an opening in the roof about 7 ft. square fitted with a removable cover, which is taken off when renewing tubes. After the specified number of tubes were replaced, the boiler was filled with water and inspection showed that a good job had been done. The boiler was then steamed up preparatory to putting in service.

When it was ready to be cut in on the line, one of the firemen went up to the top to open the stop valve, another man remaining in front on the ground floor to give the signal when the pressures were even. Just as the ground man had signaled the man on top that the valve could be opened full, one of the old tubes which was considered still good enough, blew out at the bottom drum and the man on top of the boiler was trapped. It was impossible for him to come down owing to the rush of steam upward around the boiler, but he had presence of mind to make for the opening in the roof, as shown by the sketch, as the heavy cover had not been replaced. When the man reached the ground by a circuitous route, one of his arms, his face and his neck were found to be badly scalded and he was laid up for several weeks. In less than five minutes the boiler was completely empty and it was impossible to see anything in the boiler room for some time on account of the vapor.

To prevent a man being trapped in this same location at any time in the event of the cover being in place, I have suggested extending the opening vertically and fitting a swinging door in the side, as indicated by the dotted line in the detail at the left of the illustration. I am presenting it here with the thought in mind that there might be other plants where the same conditions prevail. No doubt there are many plants where such dangers are lurking, and a little thought and the proper safeguarding might prevent a serious accident. I have often wondered why the boiler crew do not replace the cover when they get through. Had the cover been in place on this particular occasion, it is doubtful if the man referred to could have opened it from the inside, as it usually takes several men to remove it from the outside.



Arrangement of boiler and connections, also detail of proposed change to opening in roof

Cincinnati, Ohio. A. A. FETTE.

Listing of the Parts Used in the Power Plant

I have found that the listing of every part used in the plant is of surprising value to the engineer. The lists should contain name of manufacturer, serial number of each piece of equipment, together with number of such spare parts necessary to keep in stock, also length of time necessary for receiving repairs. This system not only saves time in ordering material, but reduces the loss of time owing to equipment being out of service for repairs.

After the system has been in use for a year or so, it is much easier to keep repairs in stock and ordered only as previous records show that they will be used, which not only reduces the capital tied up in spare parts and supplies, but also tends to insure continuity of operation. Many engineers will say they do not have time to do this, but it will save them considerably more time than spent in recording the items in addition to the time that ordinarily would be wasted in emergency repairs that have to be done all over again

Vermillion, S. C. L. A. COWLES.

Comments from Readers

Operating a Motor with a Grounded Commutator

The emergency armature repair described by Frank Huskinson, in the April 21 issue, is of particular interest, as it shows real ingenuity in getting out of a tight place. However, it is not always possible to drive

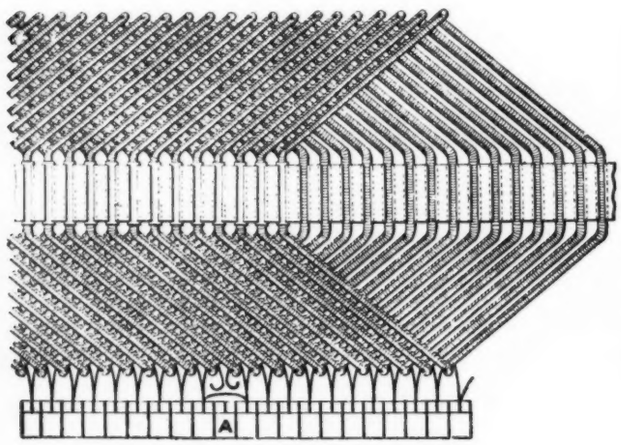


Fig. 1—Two coils cut out of winding at A

a bar down in a commutator, and as far as this part of the job was concerned, Mr. Huskinson was in luck. When the bar cannot be driven down, it would probably be possible with a small sharp chisel and a hammer to

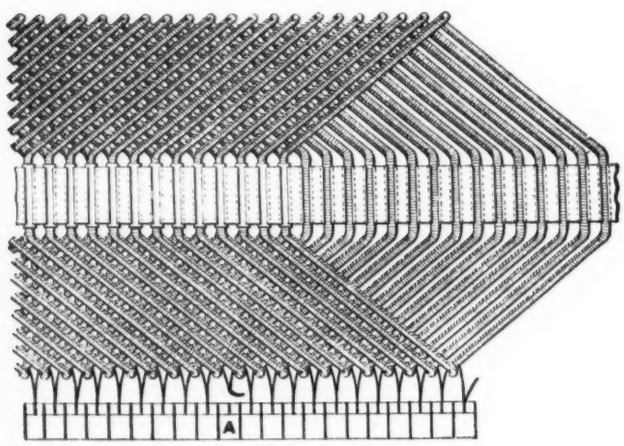


Fig. 2—Two coils disconnected from bar A but left in circuit

remove metal enough from the surface of the bar to bring it below the others, after which the water glass could be applied.

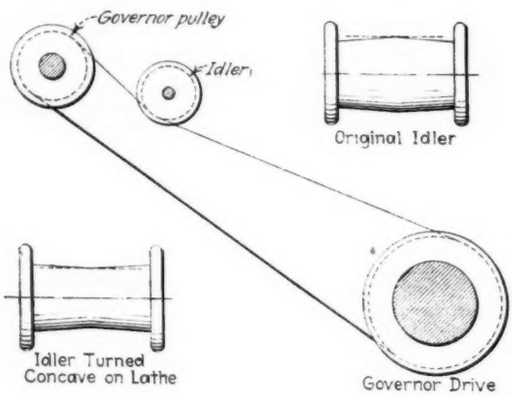
It is my understanding that Mr. Huskinson cut out two coils in the winding and closed the circuit around the insulated bar with a jumper, as *A* in Fig. 1. This is not necessary, since if the two leads taken from the grounded bar had been connected together as in Fig. 2, the circuit would have been closed with all coils in use. There is some objection to doing this on a commutator where the mica has failed between bars and caused short-circuits. Leaving the coils in circuit as in Fig. 2, causes the potential to be doubled across the insulation between the two segments to which the two coils connect. If the mica is poor, the increased potential may cause a breakdown of the insulation. In this case this objection does not exist, since the insulation must stand the full potential to ground, which is 220 volts. This was another case where Mr. Huskinson was in luck. Where commutator insulation fails to ground, it generally is not of very good quality in proximity to the defect, and line potential applied to an adjacent bar will frequently cause the insulation of this bar to fail to ground also.

If it were possible to do so, it would have been best to insulate the frame of the machine from ground, then no further repairs would have been necessary. However, care should be exercised to prevent anyone coming into contact with the frame of the machine and ground at the same time and getting a severe shock.

Philadelphia, Pa. A. A. FREDERICKS.

What Idler Pulley Gives the Best Results, Crowned or Concave?

The article by William Staniar in the March 17 issue about running a round belt on a crowned pulley reminds me of an experience I had with a governor drive on a



Arrangement of governor drive and change made in idler pulley

new engine. The general arrangement of the drive is shown in the illustration. The two pulleys and the idler were flanged and crowned and the belt would climb up on the flange of the governor pulley and run there. At first we thought the pulleys were not properly lined up, but in checking we found them to be in perfect alignment. Then I noticed that the belt was running with a high center due to the crowning of the pulleys, and the crown of the idler was the only surface in contact with

the belt. I had the idler taken to a lathe and the crown removed and the surface turned concave an amount equal to the crowning of the other two pulleys. When the belt was put back, we had no more trouble from that source.

Now, I am not sure if the crown on the idler pulley was the cause of the trouble or if it was the belt. Later on we replaced the belt with a new one, and in laying the old belt out flat on the floor it had the shape of an arc of a circle, the leather being stretched more on one side than the other. I would like the opinion of some other engineers on the subject. It would appear to me that the concave shape is the logical way to have an idler, but I have observed that they are usually crowned.

ANTHONY A. FETTE.

Cincinnati, Ohio.

Adjusting of Bourdon Pressure Gages

In the Dec. 2, 1924, issue G. E. Nichols has given some information about adjusting Bourdon pressure gages. However, he does not seem to be acquainted with the method of adjusting for uneven spring deflection in single-tube gages.

The principle of adjustment consists in varying the angle *ABC*, where *A* represents the center around which the gear segment swings, *B* the point at which the connecting link *L* pivots on the segment and *C* the

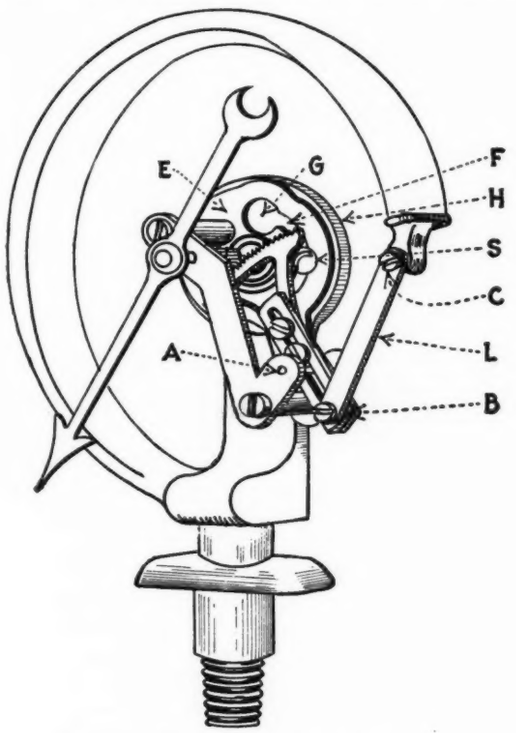
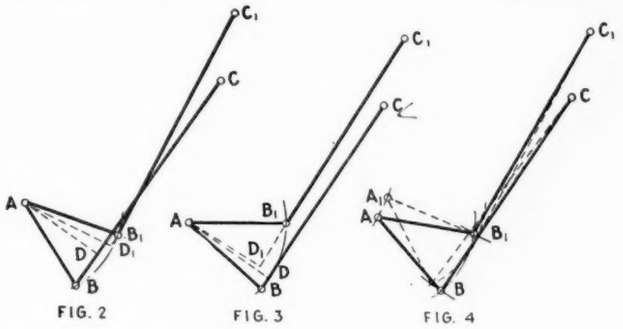


Fig. 1—Details of gage mechanism

pivot in the spring end piece at the other end of link *L*. Figs. 2 and 3 show how the angle *ABC* affects the working of the gage (the conditions as shown are exaggerated for sake of clearness).

In Fig. 2, *AB* is the position of the segment at zero pressure, AB_1 the position at maximum pressure. The shortest distances *AD* and AD_1 between *A* and the two link positions *BC* and BC_1 represent the effective lever lengths. It will be seen that *AD* is shorter than AD_1. For equal distances traversed by the spring endpiece C_1, the pointer will therefore move faster near position *B* than near position B_1.

Suppose now that length *AB* has been adjusted so that the pointer, for instance on a 100-lb. gage, covers correctly the distance 0 to 100 lb. but is too low at 50 lb. It is only necessary to bring the movement into a position similar to Fig. 2, which will increase the speed in the first half of the scale so as to bring the pointer up to 50. Inversely, if the pointer had been too high at 50, the movement should be brought into a



Figs. 2, 3 and 4—Illustrates how the angle of the connecting link and segment affects the working of the gage

position similar to Fig. 3, which produces slow speed at the beginning and high speed at the end.

There are several methods of obtaining the required adjustment. One generally used is to change the length of link *L*. In quantity manufacture it can be easily arranged to have links of assorted lengths on hand; if the first link does not give the desired result, it is replaced by a longer or shorter one as needed. The user of the gage, however, cannot apply this method.

A new movement patented by the American Schaeffer & Budenberg Corp. eliminates the exchanging of links and can also be adjusted easily by the user.

This movement has a round center plate *F* with two symmetrical slots *F* (only one visible in Fig. 1) through which the two movement fastening screws *S* are inserted. The enlargement *G* of the slots allows slipping the movement over the screw heads without removing the screws from the supporting plate. The slots allow a considerable angular adjustment of the movement, which permits the use of a single-length connecting link *L*, as the adjustment takes care of any variations in the location of spring endpiece *C*.

The round bottom plate *E* has a small extension in its center (not visible in Fig. 1) which engages a hole in the supporting plate *H* and keeps the pointer shaft in exact alignment with the dial. Fig. 4 shows the effect of this adjustment. Suppose the first adjustment was a symmetrical BAB_1, and increased speed at the beginning is required; by loosening the two screws *S* and turning the movement so that *A* is shifted to A_1, a condition similar to Fig. 2 is obtained.

R. BECK, Chief Engineer,
American Schaeffer & Budenberg Corp.
Brooklyn, N. Y.

It is not too late to do that spring cleaning of the grounds around the power plant or to plant the trees and shrubbery. Work of this kind often pays good dividends.

Questions and Answers

Conducted by

Franklin Van Winkle

Curved Arms of Cast-Iron Pulleys

Why are arms of cast-iron pulleys and flywheels sometimes made curved or S-shaped in place of being made in the form of straight radial spokes? D. J. D.

The arms are curved to prevent fracture or distortion of the rim from unequal shrinkage during cooling of the casting. A straight arm, from cooling before the rim, may cause distortion of the rim, or when the rim cools first, subsequent contraction of the arms is likely to cause at least one arm to break away from the rim, whereas a curved arm in cooling may bend in a sand mold to longer or shorter radial length as may be required by the final shrinkage of the casting.

In present-day practice curved arms are rarely used. Patterns and molds are of such forms that pulley and wheel castings will not be subjected to fractures or serious distortions from unequal cooling when the arms are made radial or slightly tapering and joined to the rim with large fillets.

Reducing Cost of Cooling Water

We have two 15-ton ice machines each using a double-pipe condenser. The water, after flowing through the condensers, is discharged to the sewer. These machines run about 15 hours a day. The present head pressure is 120 lb. and the suction is 20 lb. gage. The condensers are made up of 1¼ pipe, 15 ft. long and there are 10 pipes in each stand. How much water am I using, and how much would be saved by installing a pump and open condenser? W. A. C.

Calculations must be based upon assumptions since the actual tonnage output and water temperatures are not given. If the output be 30 tons of refrigerating duty, with a head pressure of 120 lb. gage and a suction pressure of 20 lb. gage, the amount of heat to be removed in the condenser is calculated by first finding the entropy of a pound of ammonia vapor at 20 lb. gage, this being 1.1606 (Goodenough's tables).

During adiabatic compression the entropy remains constant and at 120 lb. gage discharge pressure the superheated vapor with an entropy of 1.1606 contains approximately 621 B.t.u. per pound. When condensed at 120 gage pressure, the pound of ammonia contains 45 B.t.u. Consequently, the heat removed in the condenser per pound of ammonia is 621 — 45 = 576 B.t.u.

In evaporating in the coils a pound of ammonia will pick up the difference between the heat the liquid contains on entering the coil and the heat in it after evaporating. The heat of the vapor at 20 lb. gage is 567 B.t.u. and of the liquid at 120 lb. gage is 45. The heat absorbed in the coils is 567 — 45 = 522 B.t.u. and to perform a duty of one ton of refrigeration requires the circulation of $\frac{200}{522} = 0.382$ lb. per min. Since each pound entering the condenser throws off 576 B.t.u. to the cooling water, the heat per minute for 30 tons is $30 \times 0.382 \times 576 = 6{,}600$ B.t.u. If the water experiences a temperature rise of 10 deg., since the specific heat of water is one, $6{,}600 \div 10 = 660$ lb. of water, or approximately 80 gal. must be used per minute.

Operating 15 hours a day the water wasted to the sewer is $80 \times 60 \times 15 = 72{,}000$ gal. per day. If a greater water temperature rise is used, the amount used is less than calculated.

Under usual conditions it would pay to install a cooling tower. It should not be necessary to abandon the double-pipe condensers, for these can be placed above the cooling tower and the system arranged to have a pump pick up the water from a sump below the cooling tower and force it through the double-pipe condenser. On leaving the condenser, the water would flow down through the tower. The net saving will depend on the cost of water, the cost of the cooling tower and the cost of power for pumping. If power is expensive, it may pay to install atmospheric condensers to decrease the head pressure.

Thicker Fire Toward Bridge Wall

What is the advantage of keeping the fuel bed of a boiler furnace thicker toward the bridge wall than on the front part of the grate? C. S.

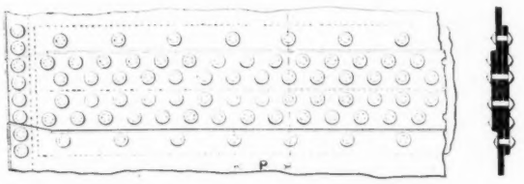
In the ordinary hand-fired boiler, with air admitted through front ashpit doors, the velocity of the air as it sweeps under the grates is checked when it reaches the bridge wall, resulting in more draft pressure and higher rate of combustion than in the front end of the furnace. This, combined with the fact that air that reaches the rear end of the ashpit is more favorable to combustion from becoming heated to somewhat higher temperature than the air drawn from other parts of the ashpit, results in a higher rate of combustion for the rear end of the furnace and unless the fuel bed is thicker toward the bridge wall there will be a smaller proportion of draft obtained for the rest of the fuel bed and the rear end will require stoking and cleaning oftener than the rest of the fire.

Efficiency of Triple-Riveted Butt and Double-Strap Joint

What would be the efficiency of a triple-riveted butt and double-strap joint in which the thickness of main plates is 7/16 in.; thickness of butt straps, 3/8 in.; tensile strength of plates, 55,000 lb. per square inch of cross-section; pitch of rivets in the outer rows, 8 in.; and diameter of rivet holes, 15/16 in.? B. T. S.

Having thickness of main plates, $\frac{7}{16} = 0.4375$ in.; thickness of butt straps $\frac{3}{8} = 0.375$ in.; tensile strength of plates, 55,000 lb. per square inch of cross-section; pitch of rivets in the outer row, 8 in. = twice the

pitch of rivets in the second and the inner rows; diameter of rivets driven to fill the holes, $\frac{15}{16} = 0.9375$ in., giving the cross-sectional area of a rivet $= (0.9375)^2 \times 0.7854 = 0.69$ sq.in.; and assuming the strength of a rivet in single shear $= 44{,}000$ lb. per square inch of cross-sectional area and shearing strength in double shear $= 88{,}000$ lb. per square inch; also assuming that the crushing strength of material $= 95{,}000$ lb. per



Butt and double-strap joint triple-riveted

square inch of projected area, then for a length of the joint equal to a unit of pitch indicated by the dimension P in the sketch,

(1) Strength of solid plate $=$

$$8 \times 0.4375 \times 55{,}000 = 192{,}500 \text{ lb.}$$

(2) Strength of plate between rivet holes in the outer row $=$

$$(8 - 0.9375) \times 0.4375 \times 55{,}000 = 169{,}941 \text{ lb.}$$

(3) Shearing strength of four (4) rivets in double shear, plus the shearing strength of one (1) rivet in single shear $=$

$$4 \times 88{,}000 \times 0.69 + 1 \times 44{,}000 \times 0.69 = 273{,}240 \text{ lb.}$$

(4) Strength of plate between rivet holes in the second row, plus the shearing strength of one (1) rivet in single shear in the outer row $=$

$$(8 \times (2 \times 0.9375)) \times 0.4375 \times 55{,}000 + 1 \times 44{,}000 \times 0.69 = 177{,}743 \text{ lb.}$$

(5) Strength of plate between rivet holes in the second row, plus the crushing strength of inside butt strap in front of one (1) rivet in the outer row $=$

$$(8 \times (2 \times 0.9375)) \times 0.4375 \times 55{,}000 + 0.9375 \times 0.375 \times 95{,}000 = 180{,}781 \text{ lb.}$$

(6) Crushing strength of plate in front of four (4) rivets, plus the crushing strength of inside butt strap in front of one (1) rivet $=$

$$4 \times 0.9375 \times 0.4375 \times 95{,}000 + 1 \times 0.9375 \times 0.375 \times 95{,}000 = 189{,}257 \text{ lb.}$$

(7) Crushing strength of plate in front of four (4) rivets, plus the shearing strength of one (1) rivet in single shear $=$

$$4 \times 0.9375 \times 0.4375 \times 95{,}000 + 1 \times 44{,}000 \times 0.69 = 186{,}219 \text{ lb.}$$

The least strength for a unit length of joint, P in the sketch, is derived from consideration (2), namely, 169,941 lb., and since according to (1) the strength of the solid plate for the same unit length of joint would be 192,500 lb., the efficiency of the joint would be,

$$169{,}941 \div 192{,}500 = 0.882, \text{ or } 88\tfrac{2}{10} \text{ per cent}$$

Number of Turns in Auto-Transformer Coils

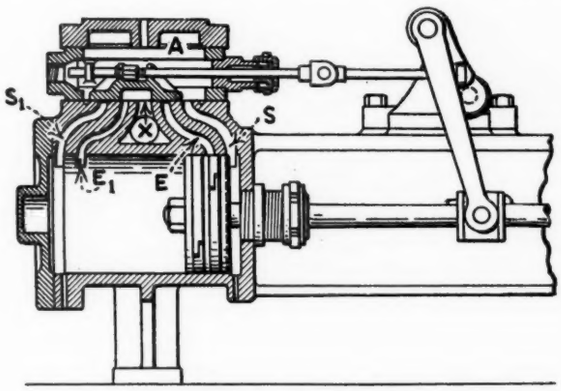
What is the formula for figuring the number of turns, and what would be the size of wire, to use on the core of an auto transformer, when the total area of the iron core, cycles per second, primary voltage and secondary or tap voltage are known? The flux density will be assumed to be 30,000 lines per square inch. The purpose of the auto-transformer is to step down from 440 to 220 volts. J. L. F.

The formula, $T = \dfrac{E \times 100{,}000{,}000}{4.44 \times NB \times A}$ will give the number of turns required in the transformer. In this formula T equals the number of turns; E the line voltage; N the frequency of the circuit in cycles per second; B the flux density in the core in lines per square inch; and A equals the cross-sectional area of the core in square inches. For the size of wire about 1,000 circ.mils per ampere may be allowed. When designing the winding of a step-down auto-transformer, the number of turns for the primary winding—that is, the winding that will be connected to the line—is obtained and then a tap taken out of this winding at the proper point to give the reduced voltage required. In this case the tap would be taken off the middle point of the winding.

Five-Ported Valve Seat of Duplex Pump

Why are the seats of the steam valves of the ordinary duplex steam pump each provided with five ports? E. S.

The figure shows a cross-section of one steam cylinder and valve of a duplex pump. The central port X is for discharge of the exhaust; E and E_1 are exhaust passages alternately in communication with X; and S and S_1 are steam passages for alternate admission of steam from the steam chest A to the ends of the cylinder. The cross-section shows the piston beginning a forward stroke. The valve has been moved forward by the piston rod of the other side of the pump so as to close the steam port S_1, admit steam behind the piston from the steam chest A through the port S, and open the exhaust port E_1 to the exhaust passage X. As the piston moves forward the valve remains stationary owing to the lost motion between the valve and its valve rod. It is to be noted that the ports S and S_1 are controlled by the valve only for admission of steam, and also that the ports E or E_1, which are



Steam ports of duplex pump

only exhaust ports, are covered by the piston before it reaches the end of a stroke. This closure of the exhaust port before the valve has uncovered the steam port, compresses the exhaust then remaining in the end of the cylinder and the steam passages, thus forming a cushion for gradually bringing the piston to rest at the end of the stroke.

[Correspondents sending us inquiries, should sign their communications with full names and post office addresses.—EDITOR.]

A new slant on things observed in and out of the power plant

What Happens and Why?

Why the Same Excess Air Gives Less Co_2 with Oil

IT IS generally understood by boiler operators that an equal percentage of CO_2 in the flue gas stands for a smaller percentage of excess air in the case of fuel oil than in the case of coal. To put it another way, the fuel oil will give a smaller percentage of CO_2 for the same amount of excess air. What is the cause of this? The answer lies in the greater amount of hydrogen contained in fuel oil.

The best way to understand this effect is to see first, what happens when

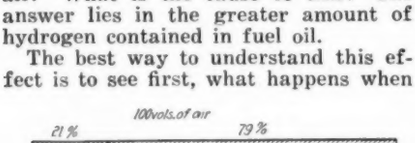


Fig. 1—Carbon burned without excess air gives 21 per cent CO_2

pure carbon is burned without the production of any CO and, second, see what happens when pure hydrogen gas is burned in air. It will then be a simple matter to study the case of fuel oil, which contains practically nothing but carbon and hydrogen.

Taking up first the case of pure carbon burned without the production of any CO, it should be remembered that air contains 20.8 per cent of oxygen by volume. We will call this 21 per cent, which is close enough for most boiler-room uses. The remaining 79 per cent is nitrogen. When carbon burns by uniting with the oxygen in the air, each cubic foot of oxygen produces exactly 1 cu.ft. of CO_2. So the combustion of carbon without excess air would show 21 per cent of CO_2 (Fig. 1).

Suppose that a small amount of pure carbon is burned in 100 cu.ft. of air (containing 21 cu.ft. of oxygen) and that the amount of CO_2 produced is 9 cu.ft. What happens is shown in Fig. 2. This combustion uses up 9 cu.ft. of oxygen, leaving 21 — 9 = 12 cu.ft. There is, of course, no change in the 79 cu.ft. of nitrogen. There will then be 79 cu.ft. of nitrogen, 12 cu.ft. of oxygen, and 9 cu.ft. of CO_2, giving a total volume of 100 cu.ft. which is equal to that of the original air. Considering this new gas mixture as flue gas, its analysis (by volume) will show 9 per cent CO_2 and 12 per cent oxygen.

As previously shown, 9 cu.ft. of oxygen was used up in producing 9 cu-ft. of CO_2, therefore we come to the conclusion that 9 cu.ft. of oxygen was used up in combustion and 12 cu.ft. was an excess. The percentage of excess air is then $\frac{12}{9} \times 100 = 133$ per cent.

Next take the case of pure hydrogen gas burned in air. In burning, hydrogen combines with oxygen and forms water which completely disappears so far as the analysis is concerned. Suppose then we burn a small amount of hydrogen in 100 cu.ft. of air (consisting of 21 cu.ft. of oxygen and 79 cu.ft. of nitrogen) and that 9 cu.ft. of oxygen is consumed. This seems simple enough, but the confusing thing is that the flue-gas analysis will not show 21 — 9 = 12 per cent of oxygen, because the total volume of gas has been reduced below 100 cu.ft. There is now 79 cu.ft. of nitrogen and 12 cu.ft. of oxygen, giving a total volume of only 91 cu.ft., so that a flue-gas analysis would show 12 ÷ 91 = 0.132 or 13.2 per cent oxygen.

If enough hydrogen were burned to use up all the oxygen, the flue-gas analysis would show 100 per cent nitrogen. A fuel containing nothing but hydrogen naturally produces no CO_2 no matter how small the excess air.

Now we are ready to consider the case of a fuel that is a mixture of carbon and hydrogen. To make the prob-

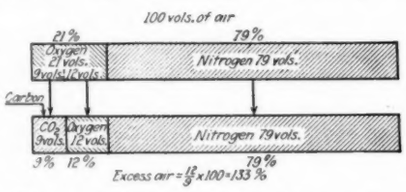


Fig. 2—When burning carbon, 9 per cent CO_2 means 133 per cent excess air

lem as practical as possible, let us take a typical fuel oil where each pound contains approximately 0.85 lb. of carbon and 0.12 lb. of combustible hydrogen. The remainder we will assume to be inert material. Each pound of carbon will consume $\frac{8}{3}$ lb. oxygen, and each pound of hydrogen will consume 8 lb. of oxygen. Therefore, whenever a pound of such fuel oil is burned, the following amounts of oxygen are required: First, to burn the carbon, $0.85 \times \frac{8}{3} = 2.26$ lb.; second, to burn the hydrogen, $0.12 \times 8 = 0.96$ lb. To express this in another way, for every pound of oxygen burning to CO_2, there is $\frac{0.96}{2.26} = 0.42$ lb. of oxygen burning to water, the latter, of course, not appearing in the analysis. For simplicity we may use the round figure of 40 per cent to represent the ratio of the oxygen that disappears to the oxygen burning to CO_2.

Start again with 100 volumes of air and as in the case where pure carbon was burned, supply enough fuel (in this case fuel oil) to consume 9 volumes of oxygen, leaving 12 volumes unconsumed. The excess air is then 133 per cent as before, but the CO_2 will be less than 9 per cent.

Of the 9 volumes of O_2 consumed only part will go to CO_2. Another part, 40 per cent as much, will burn to water with the hydrogen and disappear. The part disappearing will then be $\frac{40}{140} \times 9 = 2.6$ volumes, leaving 9 — 2.6 = 6.4 volumes of CO_2.

The flue gas will then contain 6.4 + 79 + 12 = 97.4 volumes of gas, and the percentage of CO_2 will be $\frac{6.4}{97.4} \times 100 = 6.6$ per cent, instead of 9 per cent as for pure carbon.

It should be noted that the hydrogen referred to in the foregoing does not include that which is bound up with oxygen to form the moisture in the fuel. An illustration will make this clearer. The ultimate analysis of a certain Ohio coal by the Bureau of Mines showed 3.15 per cent sulphur, 4.88 of hydrogen, 69.76 of carbon, 1.18 of nitrogen, 12.74 of oxygen and 8.29 of ash.

All the oxygen will be tied up with hydrogen. Since oxygen is combined with one eighth its weight of hydrogen in water, the 12.74 per cent of oxygen will take 12.74 ÷ 8 = 1.59 per cent of hydrogen.

This leaves 4.88 — 1.59 = 3.29 per cent of free hydrogen which may enter into combustion.

The accompanying table gives percentages of CO_2 corresponding to various percentages of excess air.

Relation to Excess Air to CO_2

RELATION OF EXCESS AIR TO CO_2

Per Cent Excess Air	Approximate Percentage of CO_2		
	Carbon	Bituminous Coal	Fuel Oil
0	21	19	16
25	17	15.5	12.5
50	14	13	10.5
75	12	11	9
100	10.5	9.5	8
125	9.5	8.5	7
150	8.5	7.5	6
175	7.5	7	5.5
200	7.0	6.5	5

Inspection of this table shows that 10.5 per cent of CO_2 with fuel oil is about equivalent to 14 per cent with coal. The fact that in practice about the same CO_2 is obtained with either fuel means that higher efficiencies are generally obtained with oil.

New and Improved Equipment

Bethlehem Steel Co. Pulverizer

The illustrations show sectional and partial assembly views of a pulverizer recently developed by the Bethlehem Steel Co., Bethlehem, Pa., which embodies certain special features. These include the use of a comparatively light-weight revolving member running at slow speed, with a view to minimizing vibration and reducing power consumption. Lubrication of all bearings is from the outside of the mill without shutdown. The control of the pressure of the grinding rolls to suit the material being ground is also accomplished from the outside.

Referring to Fig. 1, the raw coal (previously crushed to 1¼ in. or less) is fed to the mill by a feeder *A* of the swing-gate type driven through a spur gear and crank from the main driving shaft of the mill. Variation of the coal supply is made by adjusting the position of the pin *B* in the rocker arm *C* (see Fig. 2) from complete shutoff to full feed while the mill is running.

From the feeder the coal is discharged to the center of the revolving table *D*, from which point it is caused to move outward in a thin layer by centrifugal action. In moving across the slightly inclined surface of the table the coal is brought under the grinding action of the rolls *E* and reduced to the necessary fineness. The speed differential between the rolls and table develops an attrition action which assists in the grinding. As the coal reaches the periphery of the table, it is picked up by a current of air induced through the ports *F* at fairly high velocity and carried into the separating chamber above, as indicated by the arrows. The path of the dust-laden air and consequently the degree of fineness of finished product is controlled by the position of the vanes *G*, which is regulated by the handwheel *H*. An indicator is provided adjacent to the handwheel to show the position of the vanes. The function of the vanes is to increase or decrease the length of travel of the air and its contained particles from the periphery of the separator to the central discharge opening to the exhauster, which allows the desired separation to take place. In passing through the separator, any oversize particles that have been carried along are separated and returned to the grinding zone through the pipe *J*. The upper surface of the table *D* is fitted with sectional grinding plates of special steel, held in place by tapered wedge blocks and bolts. The grinding rolls are fitted with tires of special metal and these are readily renewable. The rolls run on conical roller bearings at the end of an arm pivoted from a point *K* outside the mill. The pressure between the rolls and table is regulated to suit the material or grade of coal being ground by adjustment of the tension on the springs *L*. By removing a section of the housing *M*, the tension arm *N* and the small casting *O* (see Figs. 1 and 2), the complete roll elements can be raised to a vertical position, which facilitates inspection and renewals. This feature also makes possible the replacement of the essential wearing parts of the mill, such as roller tires and table tracks, without much dismantling or the employment of hoists or chain blocks.

Referring to Fig. 1, it will be seen that the roll bearing is totally inclosed. The lubricating grease is forced into the bearing through the port *P*, and any excess must pass through the bearing and discharge outside of the mill through the space *R* between the roll shaft and the sealing tube *S*. This precludes any dust getting into the bearings and any lubricating grease getting into material. The bearing on the vertical shaft directly below the table *D* is likewise sealed against dust and lubricated from outside the mill. The thrust of the table is carried by a roller bearing on the lower end of the vertical shaft, this bearing being supplied with oil from the driving gear housing.

The exhauster for removing the fine material from the mill is independently driven and can be installed adjacent to the mill or in other location to suit installation requirements.

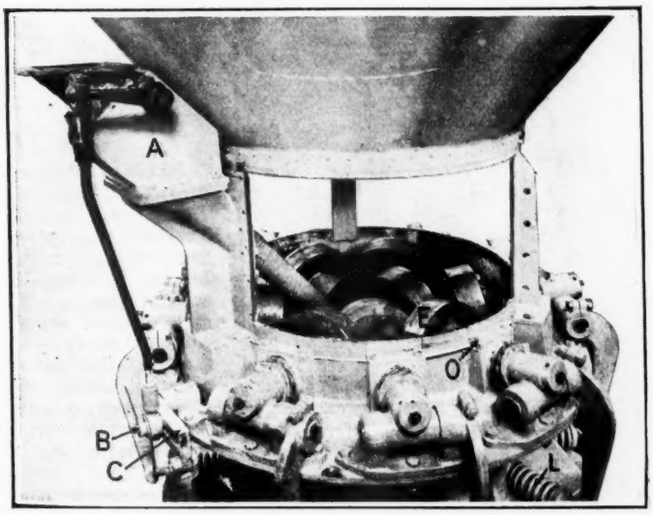


Fig. 2—Housing removed, showing pulverizing chamber

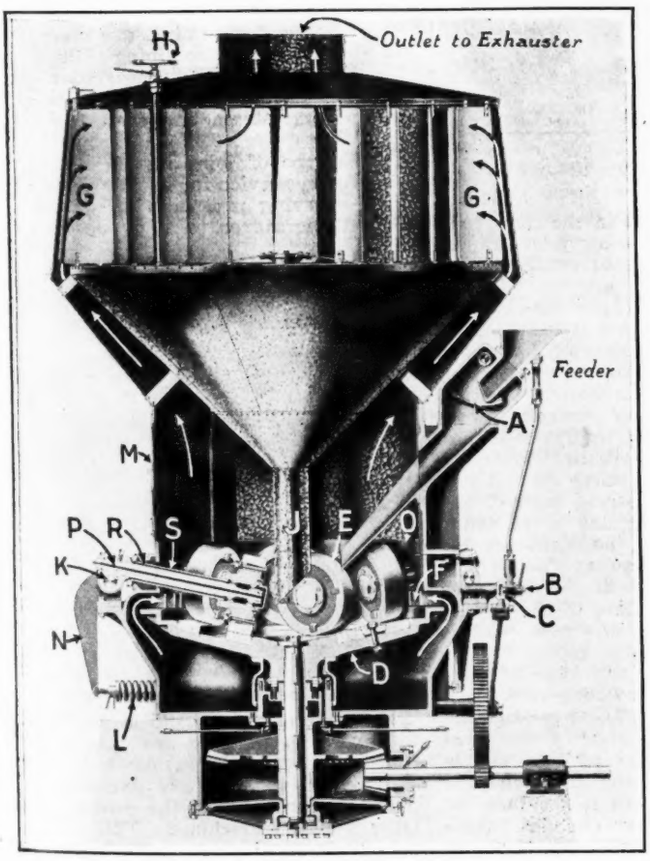


Fig. 1—Sectional view of pulverizer

Jeffrey Rigid-Hammer Coal Crusher

A crusher of the rigid hammer type designed especially to reduce in one operation run-of-mine coal to a uniform product in small sizes has been developed by the Jeffrey Manufacturing Co., Columbus, Ohio.

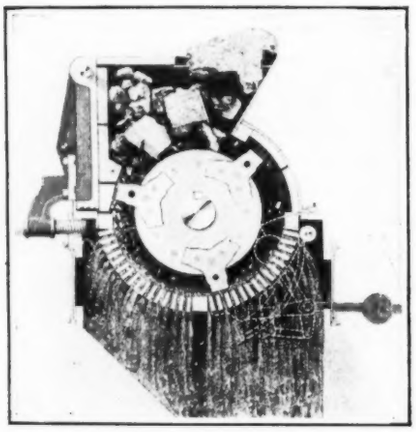


Fig. 1—Sectional view of crusher

The machines are made in several sizes, and by adjustments within each size a complete range of capacities up to hundreds of tons per hour is available. The adjustments are made in the breaker plate or screen bar spacing also by regulating the speed of the crusher rotor. General details of the machine are shown in Figs. 1 and 2.

All wearing parts are renewable, including the inside frame liners and the breaker plate. The breaker plate,

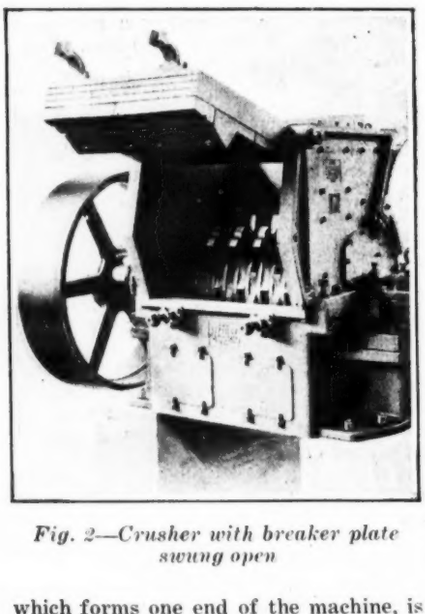


Fig. 2—Crusher with breaker plate swung open

which forms one end of the machine, is hinged, providing easy access to the crusher rotor. An adjusting screw regulates the space between the plate and the crusher teeth. A drop-bottom screen frame operated through weighted levers allows release of overloads and the removal of tramp iron or other foreign material.

The rotor is constructed with steel disks fitted with manganese steel teeth. The teeth are made with six wearing corners which are brought into service by simply turning a fresh corner to the work side. The driving pulley is affixed to the shaft by a breaking pin to protect the working part from damage through foreign matter entering the crusher with the coal.

Midwest Joint for High Pressures and Temperatures

The new Midwest Joint, made by the Midwest Piping & Supply Co., of St. Louis, Mo., is designed to eliminate gaskets without resorting to field welding the laps. A joint between two lengths of pipe (Fig. 1) is made by contact of the specially machined convex and concave spherical surfaces. The contact surfaces between the back faces of the laps and the flanges are also spherical. The spherical feature is designed to assure a tight joint and flange adjustment not only with correct pipe alignment, but also when there

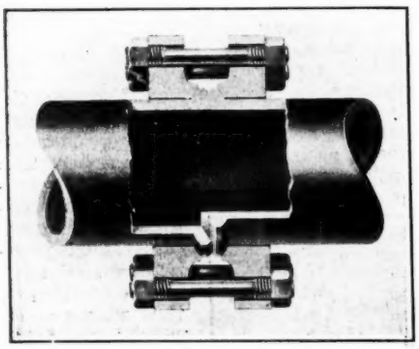


Fig. 1—Pipe-to-pipe joint

are slight deflections in the line. Acting as a ball-and-socket joint, adjustment to expansion and contraction is possible without leakage.

To accommodate deflections in the line, sufficient clearance is provided between the pipe and flanges to permit at least a 5 deg. variation in the face of the flanges from their normal position. Lineal pipe expansion generally serves to tighten joints, but this joint is also tightened by circumferential expansion.

Because of the spherical contact surfaces the maximum stress between the pipe ends of the joint, due to the flange bolting, occurs near the inside of the pipe wall rather than at the outside edge of the laps. To insure resistance to shear the thin section of the female end measured along the pipe wall is always heavier than the pipe.

The application of this type of joint to a pipe and valve or fitting connection is shown in Fig. 2. The pipe has the male end while the flange of the valve or fitting is recessed by the simple operation of machining the spherical seat upon the standard raised face, no special flange faces or changes in dimensions being required. Fig. 3 shows this joint made between valves or fittings; a steel ring (which is simply two male ends back-to-back) is used between the valve or fitting female faces.

The new Peoria Station of the Illinois Electric Power Co. has 389 Midwest Joints on the high-pressure steam piping and boiler-feed water lines. The working pressure at the turbine throttle is 375 lb., and with a superheat of 250

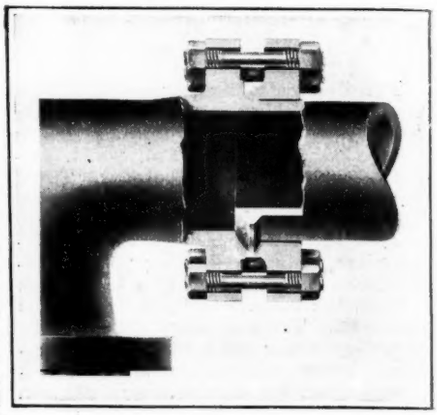


Fig. 2—Joint between pipe and valve or fitting

deg. the total steam temperature approximates 700 deg.

The first 20,000-kw. unit now being installed at the Davenport Station of the Riverside Power Manufacturing Co. (United Light & Power Co., Davenport, Iowa) has 509 of these joints upon the high-pressure steam, boiler-feed, auxiliary steam and stoker hydraulic piping. Nominal pipe sizes are from 2 to 12 in. inclusive. The piping is designed for 600-lb. service, but the actual operating conditions will be 425-lb. pressure and a total steam temperature of 700 deg. F.

This type of joint was first used in oil refinery service for hot oil and vapor lines carrying pressures up to 500 lb. and temperatures to 1,000 degrees F.

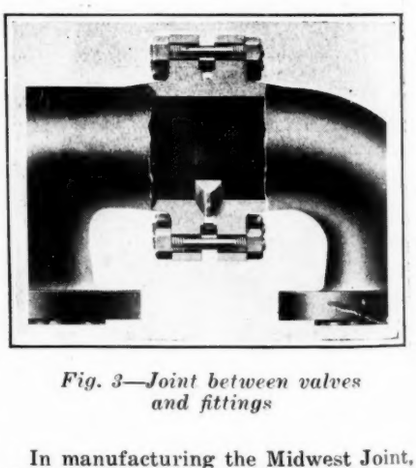


Fig. 3—Joint between valves and fittings

In manufacturing the Midwest Joint, the ends of the pipe are heated and rolled slowly into dies for either the male or female part, the excess metal is then turned off and the contact surfaces specially machined. This joint is now made in sizes from 1¼ to 24 in., inclusive, for high-pressure and high-temperature service conditions.

Analysis of Oil Flames*

By James L. Breese, Jr.
Breese Engineering Corporation, Chicago, Illinois

WHEN we attempt to burn oil we have before us the problem of first converting the hydrocarbon liquid into a saturated vapor and then applying sufficient heat to bring it to a condition called gas. With this gas produced, the next problem is mechanical. That is, we must mix the gas with sufficient oxygen, so that complete combustion can take place. So far our steps have been in the field of mechanics. We now jump into chemistry. We must raise this entire mixture to a temperature where a chemical reaction will take place between the hydrogen and oxygen, and the carbon and oxygen.

There are, broadly, two types of flames, the blue flame and the yellow flame; but there are many combinations of part-blue and part-yellow.

Blue Flame Versus Yellow

The blue flame indicates that the oxygen and the oil gas have been premixed at a temperature below that of ignition. Stated from the point of view of the result, the combination of hydrogen and oxygen is going on in step with that of the carbon and oxygen.

The yellow, or radiant, flame is an indication that the mixing is being done above the ignition temperature and after ignition has taken place, with the natural result that most of the hydrogen is united before the carbon starts, thus robbing the atmosphere of oxygen and making the incandescent carbon rise to reach out for oxygen.

The blue flame means that combustion is taking place within the entire area between the sides of the flame, whereas in the yellow flame combustion is taking place along the surface dividing the oil-gas from the air. In a stream-line flame, free from eddy currents, I have measured the incandescent wall as about $\frac{1}{32}$ in. thick, the layer immediately outside of this being mostly carbon dioxide for a thickness of about $\frac{1}{16}$ in., beyond which was pure air.

Candle the Original Oil Burner

A cross-section of a candle flame, which after all is the original and most wonderful heavy-oil burner, discloses the following: Starting from the center we have first liquid oil, or paraffin, in the wick. Next we have a concentric ring of saturated oil vapor well below the ignition point. Outside of this is a ring of oil gas, the temperature on its outer edges being up to the ignition point. The next ring is a layer not over $\frac{1}{32}$ in. of incandescent carbon particles kept in this state by the heat of the chemical reaction of oxygen from the layer of air and the hydrogen which shoots through the incandescent wall and steals the oxygen, and the next layer, which is rich in carbon dioxide from the chemical reaction of the air and the incandescent carbon, and finally the air itself.

What would happen if this miniature burner, which gives perfect combustion and no noise, on the dining-room table, were properly installed in a house-heating boiler? If we should put the candle in the center of the boiler, the first objection would be that it did not heat the house. The answer to this would be simple; put in a larger candle. Now when we put in a larger candle we increase the amount of oil gas given off, but we no not supply any means for increasing the diameter of the circle of combustion, therefore the flame must rise vertically in its attempt to reach out for oxygen. Let us suppose that we put in such a large candle that the flame was carried up into the boiler surfaces. We would then have a smoky flame, and soot would be deposited in the boiler walls and up the chimney.

Air Blast Brings New Troubles

The next logical step would be to blow additional air into the flame, so that combustion would be accomplished before it traveled to the top of the boiler.

The smoke trouble having been overcome, we are in more trouble. We find that if the blast of air is a little too hard, the flame blows out; or that if it does not blow too hard, the chilling effect of too much air is likely to cool the upper end of the flame and again produce smoke, although excess air is at hand.

The problem is now getting interesting. We have found that the addition of air is not the cure-all, but the temperature and velocity of this air is as important as the amount. The next step is usually to try the blowpipe action; that is, to have a jet of air impinge on the flame, the diameter of the jet being relatively small with respect to the flame, so that a blast of air is thrown completely through the area formerly taken by the flame, and the suction action of this jet draws the balance of the flame into the path of the blowpipe stream.

Good combustion always results from this method, and we think the oil burner is going to be a success, but soon a complaint is registered that the noise is excessive; and if we are engineers, not salesmen, further research is necessary.

Leaving our candle oil burner for a while, let us examine a few of the successful flames and measure their temperatures, the velocity of flame propagation and the velocity of the admitted air at the time it strikes the oil gas, at or above ignition temperatures.

The velocity of flame propagation for wood lies between 200 and 900 ft. per min. Next, take the gas jet. We find that if a relatively large amount of gas comes out of a round hole at low velocity, the gas flame will smoke. However, if we have two openings at ninety degrees to each other, so that the two jets impinge and give us a relatively large exposed surface, the gas will burn without smoke. This is the common type of flat-flame gas jet. Here we have conditions different from the log of wood. Instead of moving the air rapidly over the surface of the gas generator, which was the log of wood, we move the gas at high velocity through the air and give it a large exposed surface to the oxygen of the air. Ordinary city gas has an average tip velocity of five or six thousand feet per minute, and the flame will leave the tip at this velocity. We are beginning to get some data.

Now turn to the oxyacetylene blow-torch. Here we have a flame no larger than a dining-table candle flame, but producing many times as much heat and a much higher temperature. We find here that the velocity at which the gas and oxygen can be sent from the nozzle without the flame leaving the tip, is all out of proportion to the velocities mentioned in the first two cases. Why is this? The answer is that the velocity of flame propagation is a function of temperature. The reason for a higher temperature is the use of pure oxygen, because no nitrogen has to be heated and the entire heat of combustion is produced in the cone of mixed oxygen and hydrocarbon. We also find with the acetylene torch, that the blue flame gives a higher temperature, whereas a yellow flame, as might be expected, gives off more radiant heat.

Use Determines Proper Flame Color

Without burdening you with the measurements of this proportion, it will be enough to state that the total amount of heat generated is the same, and that in the design of our final burner the decision as to whether we will have the blue flame or a yellow flame is largely a matter of the application of that flame. We now have enough data to analyze the flame produced by our burner, to see whether we are accomplishing the results for which we designed the apparatus.

Suppose we have in mind a blue-flame burner. To obtain a blue flame, we have found that it is necessary to premix the oil gas with air. We know the temperature of saturated oil vapor, and we know the cracking temperature of this vapor. So the problem is merely to arrange mechanical means for producing and mixing the oil vapor and air between these two temperatures, bearing in mind that as we increase the temperature beyond the minimum temperature of saturation, our flame propagation velocity will increase, and in order to keep the flame from burning back into the mixing chamber, tip velocities must be kept above the velocity of flame propagation for the particular mixture and temperature chosen. This is usually done by using small apertures, and a large number of these, to give the air surface necessary. This type of flame is well adapted to boilers with small flue passages, and such applications as melting pots, where high temperature and relatively small surfaces are available for heat absorption. Owing to the fact that the

*Abstract of paper delivered at the Second Annual Convention and Exposition of the American Association of Oil Burner Manufacturers, Chicago, April, 1925.

flame propagation is a function of the temperature, and also of the proportion of air and oil gas in the primary mixture, the proportions of such a burner must be carefully calculated, and for this same reason a small range between high and low setting will exist.

The yellow-flame burner is more generally adaptable to all classes of work except melting pots, and is therefore the type usually attempted.

Let us review the data we have obtained and now construct our yellow-flame burner. We have decided how much heat we wish to produce in a given time. We therefore know the amount of liquid fuel to be fed. From this we know the amount of air necessary for complete combustion. The amount of space available for this combustion must be determined. From this we can calculate the velocity at which the air is to be delivered. If we wish to make use of the radiant heat of the flame, as for instance in stoves and hot-air furnaces, the shape of the flame is of prime importance, as the radiant heat, which amounts to about 30 per cent, is emitted from the surface of the flame and in a direction perpendicular to the surface. Therefore if we have a cylindrical surface to heat, we should produce a cylindrical flame surface. The shape of a flame is determined by the shape of the outside surface of the oil gas produced. It may be controlled by the direction and velocity of the liquid oil and of the impinging air.

As all the mixing of the oxygen and hydrocarbon must be made along the surface between the air and the outer surface of the oil gas, it is essential that we provide means for as large a surface as possible, and further means for keeping the oil gas up to the ignition point until the reaction between the hydrocarbon and oxygen is completed. Various methods will at once be apparent, such as using a firebrick target or bringing the tail of the flame around to the initial ignition point, thus using the heat from the hydrogen a second time, or by setting up eddy currents with the forced air. Noise will occur, however, wherever air is admitted at a velocity greater than the rate of the flame propagation for the particular mixture and temperature. Smoke will occur wherever the incandescent carbon is allowed to cool down below the ignition point from admitting either too much air, which will chill the carbon, or insufficient air, which allows the carbon to travel too far before meeting its oxygen affinity.

Tests on Condenser Auxiliaries

By J. H. Bell
Sales Engineer, Wheeler Condenser and Engineering Company

This supplements a previous article, by the same author, "Testing Surface Condensers Equipped with Steam-Jet Air Pumps," which appeared in the April 28 issue

As nearly all condenser installations vary somewhat with regard to their heat balance and also the station heat balance, it is impracticable to attempt to set forth any standard way of correlating the tests on the auxiliaries with the condenser, or the condensing unit with the station heat balance.

The following tabulated forms are given for the separate tests on the auxiliaries. These forms are sufficiently comprehensive to eliminate a detailed discussion; however, a few points with regard to these will be brought forth.

TABLE I—STEAM JET AIR-PUMP MEASUREMENTS

(a) Absolute steam pressure at ejector throttle .....lb. per sq.in.
(b) Quality of steam at ejector throttle ...deg. F. superheat or per cent moisure
(c) Amount of steam used, first stage nozzles .....lb. per hr.
(d) Amount of steam used, second stage nozzles .....lb. per hr.
(e) Absolute air vapor pressure at main suction nozzle.....inches of mercury
(f) Temperature of air vapor at main suction nozzle .....deg. F.
(g) Absolute air vapor pressure at suction nozzles, second stage..inches of mercury
(h) Temperature of air vapor at suction nozzle, second stage.....deg. F.
(i) Temperature of water entering intercooler, (if any—surface or jet)...deg. F.
(j) Temperature of water leaving intercooler .....deg. F.
(k) Amount of water used in intercooler .....gal. per min.
(l) Amount of condensate leaving intercooler, (if surface).....lb. per hr.
(m) Temperature of condensate leaving intercooler .....deg. F.
(n) Absolute pressure at exhaust nozzle .....lb. per sq.in.
(o) Temperature at exhaust nozzle.deg. F.
(p) Actual amount of air discharged, (as measured by gasometer or orifice)..... ...cu.ft. per min. at 60 deg. and 14.7 lb.

The quantity (c) Table I is obtained by breaking the connection between the intercondenser and the main condenser and causing the condensate from the primary jets to run into a sealed tank and either weighing or directly measuring the amount of condensate. The quantity (d) is found by breaking the connection from the after condenser or water trap of the steam-jet air pump, as the case may be, and directly weighing or measuring the condensate in an open tank or container.

If the after-condenser is equipped with a water trap, the tap into the main condenser must be plugged when the pipe line from that to the main condenser is broken. The temperature and quantity of air exhausted from the air pump is obtained so that the number of B.t.u. lost in this manner may be determined. The formula for determining the number of B.t.u. thus lost is

$$\text{B.t.u.} = (h_1 - h_2)\, W$$

in which

h_1 = Total heat above 32 deg. of air steam mixture at its temperature of discharge from after condenser per pound of dry air discharged;

h_2 = Total heat above 32 deg. of dry saturated air steam mixture at temperature of condensate leaving after-condenser per pound of dry air discharged.

W = Weight of dry air discharged.

The B.t.u. given to the circulating water going through the steam-jet air pump, when the circulating water is the condensate from the main unit, are not lost, as they heat up the condensate. The steam supplied the primary and secondary jets is condensed in the inter and after condensers of the steam-jet air pump and returned to the hotwell of the main unit.

The difference between the number of B.t.u. that are either converted into useful work or saved and the total number of B.t.u. in the steam supplied the air pump will be found exceedingly small.

TABLE II—CIRCULATING-PUMP MEASUREMENTS

(a) Amount of circulating water (measured if possible).....gal. per min.
(b) Circulating water pressure above atmospheric.
1. At condenser inlet nozzle...ft. water
2. At condenser outlet nozzle...ft. water
3. Difference in level between circulating nozzles center lines.....ft.
4. Net condenser circulating friction .....ft. water
(c) Speed.
(d)
1. Pressure at pump intake nozzle..... .....ft. water
2. Pressure at discharge.....ft. water
3. Difference in level of gages..ft. water
4. Total corrected pumping head.ft. water
(e) Absolute pressure at throttle..... .....lb. per sq.in.
1. Quality of steam at throttle per cent moisture or deg. superheat.
(f) Absolute pressure at exhaust nozzle .....lb. per sq.in.
(g) Total i.hp. or b.hp., or electrical hp. if motor-driven.
(h) Weight of steam consumed per hour.lb.

The test on the circulating pump as in Table II is conducted in the same manner that tests are conducted on other types of centrifugal circulating or pressure pumps; however, some condensers operate under a combined pressure and siphonic head. In installations where this condition exists, the siphonic head must be subtracted from the total head on the pump.

TABLE III—CONDENSATE PUMP MEASUREMENTS

(a) Speed of pump.....r.p.m.
(b) Heat contained in condensate above 32 deg. F. .....B.t.u.
(c) Total amount of water handled per hour .....lb.
1. Rate per minute.....gal. per min.
(d) Water pressures:
1. Pump discharge pressure, (corr. to center line of pump) .....ft.
2. Pump suction pressure, (corr. to center line of pump) .....ft.
3. Total head on pump.....ft.
4. Water level in condenser or hotwell above center line of pump.....ft.
(e) Water horsepower from above.....hp.
(f) Power required to drive, if motor-driven .....b.hp.
(g) Absolute pressure at throttle..... .....lb. per sq.in.
(h) Quality of steam..... .....per cent moisture or deg. superheat
(i) Absolute pressure at exhaust..... .....lb. per sq.in.
(j) Steam per hour required to drive, (if steam driven) .....lb.

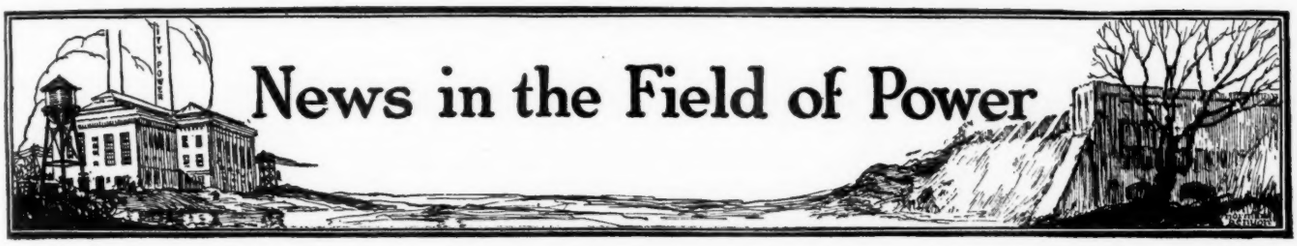
The formula for finding (e) in Table III is,

$$W.\,Hp. = \frac{g.p.m. \times head\ in\ lb.}{1715} = \frac{W \times H}{33{,}000}$$

in which

W = Weight of water per min. in lb.
H = Total head in ft.

The total head on the condensate pump, Table III, is equal to the sum of the vacuum head and the external head minus the positive head of water on the suction side.



New Hydro Plant for Mississippi

Plans for a power development on the Mississippi River at Rice, 15 miles north of St. Cloud, Minn., have been announced by the Minnesota Power & Light Co. The new plant is to have a capacity of about 16,500 hp. and is estimated to cost about $2,000,000.

Conowingo Project Being Checked Up

Representatives of the Federal Power Commission are engaged in checking the surveys of project lands, which the Susquehanna Power Co. is making. This is a part of the investigation incident to prelicense expenditures, the total of which must be established before the license is issued.

Export of Steam Turbines Increases During March

According to preliminary figures released by the Department of Commerce, there was a considerable decrease of exports of both direct-current and alternating-current generators as compared with March of 1924. There was, however, a decided increase in steam turbine generator sets during the month, as well as accessories and parts for electric generators, which caused exports of the generator class as a whole to be higher than the total reached a year ago. The export of storage batteries decreased about $120,000. Power transformers fell off 80 per cent to $99,856 and other transformers to $176,002. Rectifiers, motor generators and converters increased about 25 per cent to $55,375. Transmission and distribution apparatus as a whole increased $118,676, or about 19 per cent.

Japan Has New Law Regarding Power-Plant Generation

Francis Hodgkinson, chief engineer of the South Philadelphia Works of the Westinghouse Electric & Manufacturing Co., started on April 30 for San Francisco from where he is sailing May 12 for Japan. Mr. Hodgkinson will spend three months in Japan consulting with Japanese power engineers on problems raised by the law which provides that all hydro-electric plants hereafter must supply at least 10 per cent of their power output through steam generation. The new law will require considerable construction work to meet its requirements.

Mr. Hodgkinson will also act as a formal messenger of the A.S.M.E., the president of which, Dr. W. F. Durand, has prepared messages of greeting and good-will to the three big engineering societies of Japan.

W. H. Wiley, Treasurer of A.S.M.E. Dies on May 1

The well-known publisher of technical and scientific books, William H. Wiley, who had been treasurer of the A.S.M.E. for forty odd years, died suddenly on May 1. He was born in New York City in 1842, received his A.B. degree from the College of the City of New York in 1861, and his C.E. degree from Rensselaer Polytechnic Institute in 1866.

Since 1876 Major Wiley, who was a veteran of the Civil War, had been a publisher of scientific books. He was also a prominent member of the 58th, 59th and 61st Congress from New Jersey, and was president of the International Jury of the Brussels Exposition in 1897 and had been correspondent for London *Engineering* for many years. Besides being a member of the A.S.M.E., and its treasurer, he was a member of the A.S.C.E., A.I.E.E., A.I.M.& M.E., and other national and foreign scientific societies.

William H. Wiley

Another Austrian Hydro Power Project Planned

The Bruck - Mixnitz hydro - electric power plant, which will utilize a fall of 60 ft. in the River Mur between Bruck and Kirchdorf, has preliminary work under way and the project will probably be completed by the end of 1927.

The plant will have three 8,000-kva. Francis turbine units, and will connect up with the central power station on the Teigitsch River. The power that will be produced is intended primarily for the Upper Styrian industries and to a less extent for lower Austria and Vienna, while the Teigitsch power plant, recently completed, furnishes electric power for the City of Graz and the district of central Styria, according to *Commerce Reports*.

Bavaria Has Large Water-Power Resources

It is estimated that the Province of Bavaria can produce approximately 2,000,000 hp. of hydro-electric energy, of which 540,000 hp., or 27 per cent, has already been developed. Another 50 plants, with a total of 50,000 hp., are under construction, while 145 plants, totaling 400,000 hp., are contemplated. This total, 990,000 hp., represents practically one-half of Bavaria's potential hydro-electric power.

Diesel Engines Discussed by Royal Society

Sweeping statements were made by Lord Bearsted, the founder of the Shell Transport & Trading Co. recently, in presiding at a lecture at the Royal Society of Arts by Sir J. Fortescue Flannery on the "Diesel Engine in Navigation." In Lord Bearsted's opinion Diesel-engined tonnage will entirely replace steam tonnage in the merchant fleets of the world.

Lord Birkenhead agreed that the use of oil in place of coal as fuel for ships raised a question of serious importance for the British coal industry. If the production of oil in 1924 were taken at 16,000,000 tons (the figure given by Lord Bearsted), then the amount of Diesel oil made available would be sufficient to displace 300,000,000 tons of coal. Any such displacement would have a serious effect upon the coal export trade of Great Britain.

Streams Commission To Be Enlarged

The International Streams Commission, of which Dr. Elwood Mead is chairman of the American section, is to be enlarged. Two new members of the commission probably will be named.

In addition to Dr. Mead the present American members of the commission are General Lansing H. Beach, formerly chief of engineers and W. E. Anderson, of Texas.

The commission's study is to cover both the Rio Grande and Colorado Rivers. Mexico has asked that ten months be allowed for the members of its section of the commission to familiarize themselves with the situation and with the work done by the Diaz Commission prior to 1910.

The Rio Grande Commission, of which Secretary Hoover is chairman, is to deal with the river above El Paso. The problem is to determine the respective shares of water to which Texas, New Mexico and Colorado are entitled. Texas only recently was in a position to name its member of the commission. This now has been done, however, but hearings will not be held until fall.

Grand Falls Hydro Plant To Cost $6,000,000

The New Brunswick government's hydro-electric development at Grand Falls will cost $6,000,000 for initial provision for 60,000 to 80,000 hp. The work will probably take two years. More than $500,000 worth of actual construction will be completed by Oct. 31, 1925, according to recent announcements.

Tennessee River Project Includes Twelve Dams

Delegates attending the convention of the Tennessee River Improvement Association, meeting in Chattanooga on the 100th anniversary of the beginning of the movement to improve the Tennessee River through government aid, held recently, voted an appropriation of $60,000 for the advancement of the association's work during the coming year.

This action was taken after principal speakers, including Maj.-Gen. Lansing H. Beach, former chief of U. S. Engineers; L. D. Tyson, Senator from Tennessee; John H. Small, president of the National Inland Waterways and Harbors Congress, Washington, D. C., stressed the point that the association's plan of developing the Tennessee River and tributaries along lines suggested by Maj. H. C. Fiske, U. S. District Engineer, Chattanooga, constituted one of the most important movements ever undertaken in the interests of a greater development of the navigation and hydro-electric possibilities of inland waterways in the United States. It was pointed out that the proposed plan for the development of the Tennessee River could be successfully employed in the development of numerous rivers in other sections of the country, with the result that the United States would have available navigation and power resources beyond duplication in any other country.

The proposed plan of developing the Tennessee River system, as outlined by Dr. W. G. Waldo, chief engineer of the River Improvement Association, calls for the erection of twelve navigation and power dams between Muscle Shoals and the origin of the Tennessee and Clinch Rivers. When completed, the proposed twelve dams will serve the dual purpose of each, producing vast quantities of primary power, and of acting as a great slackwater reservoir system, assuring uninterrupted flow for the operation of the government owned power dams at Muscle Shoals, thus increasing the efficiency of these developments at least 100 per cent from a primary power standpoint. The complete system of the proposed dams will have a capacity of over 2,000,000 hp. per twelve-hour day.

With this unsurpassed volume of energy available for power purposes, it was stated that an immediate exploitation of the rich sources of lumber, coal, iron and minerals and other raw materials abundant in this region would follow with the result that the South would become an important industrial section.

Officials of the association stated that as a result of the five-year government survey under the direction of Major Fiske, the dam sites have not only been selected, but the work has reached the point where private capital has made application to the government for permission to build each of the proposed dams without expense to the government in exchange for power rights.

Milan R. Bump Dies Suddenly in Denver

Milan R. Bump, president of the National Electric Light Association in 1922, and chief engineer of the Henry L. Doherty & Co., died after two days' illness, on May 5, at Denver, Colo., from heart failure. Mr. Bump was born March 18, 1881, at Rock Falls, Wis., and passed his boyhood in Spokane, Wash., where he received his early education in the public schools. At the age of twenty-one he was graduated in electrical engineering from the University of Wisconsin.

Milan R. Bump

Immediately he entered upon engineering work with the Washington Water Power Co. A year later he went back to the university where he was an instructor in electrical engineering for a year. In 1904 he became associated with the Henry L. Doherty company, with which he has remained since, with the exception of six months, as chief engineer of the organization in charge of all engineering and of the construction and operating departments of the public-utility division.

Tidal Power Project Gets Encouragement

Dexter P. Cooper, hydraulic engineer, who has been interested for some years in developing power from the tides in Passamaquoddy Bay, Maine, at the mouth of the St. Croix River, has recently been in consultation with Premier Vinoit of New Brunswick, and expects to present his project to the Dominion and Provincial government of New Brunswick in the near future. The Maine legislature is reported as having passed a bill giving authority for the project which is expected to involve a $100,000,000 expenditure and to develop 600,000 horsepower.

American Standards Committee Forms Advisory Board

The American Standards Committee has formed an advisory committee to facilitate and expedite the work of the Committee in a united effort against industrial waste. The advisory committee will be composed of: J. A. Farrell, president of the U. S. Steel Corp.; G. B. Cortelyou, president of the Consolidated Gas Co., of New York; J. W. Lieb, vice-president of the New York Edison Co.; L. F. Loree, president of the Delaware & Hudson Co.; Gerard Swope, president of the General Electric Co.

Hitherto the movement has been largely centered in and carried on by the technical men. The appointment of this committee marks a definite recognition of the fact that standardization has now become a managerial problem in industrial production, distribution and utilization and as such deserves the fullest industrial support.

Lake Almanor Dam To Be Raised

The storage capacity of Lake Almanor, the main storage reservoir for the hydro-electric plants of the Great Western Power Co. on the Feather River in northern California, will be increased from 300,000 acre-ft. to 1,300,000 acre-ft., by raising the present dam 46 ft. The reservoir thus created will cover an area of 45 square miles and will have a storage capacity in excess of all other storage reservoirs in California combined.

This construction project, which has already been started, will require the expenditure of approximately two million dollars over a period of two years and is the most important step in the company's $200,000.000 program for the development of its Feather River power holdings, which constitute the largest single power development area in California. Two large hydro-electric plants are already in operation.

Muscle Shoals Commission Members at Work

Questions involved in the Muscle Shoals inquiry were discussed informally this week by Commissioners Curtis, McClellan and Bower. While the conferences were held at the headquarters of the commission in the rooms of the Military Affairs Committee of the House of Representatives, the gathering was not designated as a meeting of the Commission. Professor Curtis stated that he has been devoting much of his time to a study of the existing processes of nitrogen fixation with the idea of forming his own opinion as to whether any one of them has been brought to a commercial stage. In his opinion one of the fundamental points that must be established before the Commission can make recommendations is the prospect of successful operation on a commercial basis.

Commissioner McClellan has devoted much of his time thus far to a study of the literature that has been built up since the disposition of the government's Muscle Shoals properties came up for discussion in Congress.

Large Frequency Converter Set for Chicago

The Commonwealth Edison Co. recently awarded to the Westinghouse Electric & Manufacturing Co., a contract for the world's largest frequency converter set. This set has a capacity of 40,000 kva. and will be used for tying together the Commonwealth's 60-cycle and 25-cycle systems.

The latest refinements in design will be incorporated in this set, and it will be equipped with a motor-operated frame-rotating device, a direct-connected induction starting motor, and two direct-connected exciters.

Electrochemical Commission Discusses Rating and Testing

At The Hague (Holland) meeting of the International Electrochemical Commission, April 16-23 about 100 delegates were in attendance. The two subjects considered of most interest to power-plant engineers was the rating of electric generators and testing of transformer oil. The use of embedded temperature detectors and the limiting temperatures allowed for electric machines by this method of measurement were the principal rating matters dealt with. There were some differences in the figures proposed by the various national committees and the subject was thoroughly discussed with the final result unanimously adopted as follows:

Steam-turbine driven rotors insulated with "Class B" insulation (mica or asbestos), 90 deg. C. rise; salient-pole machines "Class A" insulation (cotton, silk, paper and like materials), 60 deg., and "Class B," 80 deg. rise; for stators having two coil sides per slot, "Class A" insulation 60 deg., and "Class B," 80 deg. For stators with one coil side per slot, employing "Class B" insulation, the limiting temperature rise was fixed at 85 deg. C. with the detector placed against the copper and 70 deg. C. when the detector is placed at the top or bottom of the slot; this figure to be decreased 1.5 deg. for each 1,000 volts above a rated 7,000. The one coil side per slot construction is not employed in the United States.

The advisory committee on prime movers decided to ask the various national committees to make proposals on four codes, namely: Steam Turbines; Water Turbines; Reciprocating Engines; Internal-combustion Engines. In the consideration of transformer oil the main discussion centered on the sludge test. Eight or ten methods were advocated, but there was universal agreement that no method could yet be considered standard. The invitation of the A.S.T.M., through the United States commission, for the European countries to participate in a series of tests on various grades of oil by various methods, was accepted and a committee was appointed to supervise the carrying out of these international tests. It was decided that the following points should be taken into account in judging results: A—Development of acid with time; B—Time required for first appearance of sludge; C—Rate of sludge formation when started.

Decision was taken to recommend the Pensky-Martin closed cup for taking flash-point temperatures and a 145 deg. C. for flash-point temperature was discussed but no final decision was taken.

Delaware River Compact Delayed Until 1927

The Delaware River Compact, reported in the issues of Feb. 3 and March 24, 1925, has met with delay.

In New Jersey the legislature referred the matter to a select board for consideration along with the water situation in all parts of the state.

In Pennsylvania the Compact, as recommended by the Treaty Commission, after having passed the Senate, was amended in the Assembly to include certain reservations proposed by New Jersey. It then passed the Assembly but failed in the Senate. As the Pennsylvania legislature does not meet again until 1927, final action is deferred until that time. The New York State Compact, with the amendments and reservations proposed by New Jersey, was passed without opposition and the law adopting it signed by Governor Smith on March 18.

Refractories Institute Organized

The American Refractories Institute, which held its first meeting at the Mellon Institute April 14, was attended by 36 manufacturers of refractories and 26 technical men and representatives of the consuming public. Talks and papers were presented by J. D. Ramsay, Dr. E. R. Weidlein, director of Mellon Institute, H. L. Dixon, A. J. Farber, M. C. Booze, and S. M. Phelps.

A board of directors was elected as follows: To serve one year—F. R. Valentine, Woodbridge, N. J.; G. H. Diack, Lock Haven, Pa.; P. S. Kier, Pittsburgh; E. F. Myers, Ironton, Ohio; A. B. Walsh, St. Louis; F. J. Helwig, Pueblo, Colo.; W. L. Stapler, Atlanta. To serve two years—J. M. McKinley, Curwensville, Pa.; C. C. Edmunds, Pittsburgh; C. E. Kapitzky, Cleveland; E. M. Weinfurtner, Ashland, Ky.; C. S. Reed, Chicago; J. L. Green, St. Louis; J. T. Roberts, San Francisco. To serve three years—G. A. Balz, Perth Amboy, N. J.; J. D. Ramsay, St. Marys, Pa.; J. E. Lewis, Pittsburgh; Burrows Sloan, Philadelphia; A. P. Taylor, Cincinnati, Ohio; A. P. Green, Mexico, Mo.; H. L. Tredennick, Johnstown, Pa.

San Joaquin Plans To Spend $8,000,000 This Year

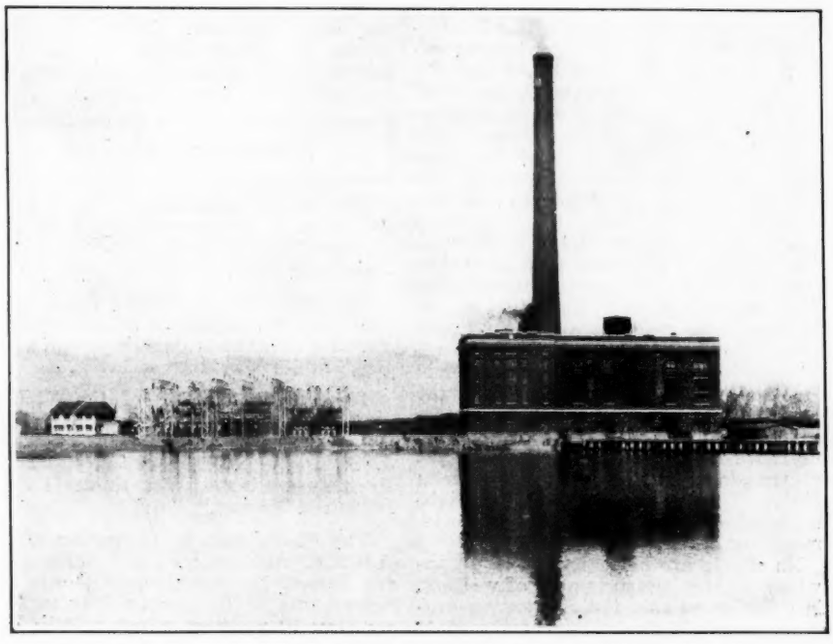
A development program for this year involving the expenditure of eight million dollars and the construction of a 28,500-kw. hydro-electric plant has been announced by A. Emory Wishon, vice-president and general manager of the San Joaquin Light & Power Corp., Fresno, Calif. In this year's budget $1,250,000 has been alloted for construction work on the Balch plant of the Kings River project, briefly described in *Power*, April 7, page 555. This plant will cost $5,000,000 and be ready for operation Jan. 1, 1927.

During the coming year the company will have available 25,000 hp. from the Exchequer plant of the Merced Irrigation District, which has been contracted for for a period of years. This will meet the growth in load until the completion of the new plant.

Valmont Plant of the Public Service Co. of Colorado

The Valmont plant was recently brought into operation by the Public Service Co. of Colorado. Located on the shores of an artificial lake, this plant utilizes the lignite coals of northern Colorado in pulverized form as generating fuel. One 20,000-kw. unit of an ultimate development of 250,000 kw. receives steam from four 1,400-sq.ft. heating surface boilers.

This plant was described briefly in *Power* March 3, 1925, page 357.



Valmont plant which burns pulverized Colorado lignite coal

Bolivia To Hold Industrial Exhibition

An industrial exhibition will be one of the features of Bolivia's Centennial which will be commemorated in August. American participation has been requested formally.

The Bolivian government offers free sites for exhibits. Reduced freight rates for goods to be exhibited have been arranged. Exhibits will be admitted duty-free.

N.E.L.A. Plans Enjoyable Trips for Delegates

Plans for the forty-eighth annual convention of the National Electric Light Association to be held in San Francisco, June 15-19, are rapidly developing. From present indications there will be approximately 5,000 visitors in attendance, of whom 2,000 or more will come from east of the Mississippi River. On April 1 hotel reservations for Eastern delegates were in excess of 500 and reservations were ready to close on the four special trains that will carry visitors from various sections of the East to the Pacific Coast.

Present plans include a series of inspection trips to many of the large projects for the delegates to the convention. Those coming through the Pacific Southwest will visit the two new steam stations in Los Angeles, the 70,000-kw. Long Beach No. 2 plant of the Southern California Edison Co., and the 30,000-kw. Seal Beach plant of the Los Angeles Gas & Electric Corp. A trip also is planned to the Big Creek-San Joaquin project of the Southern California Edison Co., where 1,300,000 hp. is in the course of development in a chain of eighteen hydro-electric plants.

The San Joaquin Light & Power Corp. will conduct a trip over its Crane Valley system of plants, including a visit to its Kings River project where work is under way on the Balch plant. This station will operate under a head of 2,470 ft. Trips will be made to the Pit River project of the Pacific Gas & Electric Co., where construction is progressing on two plants, Pit No. 3 and Pit No. 4, having an aggregate capacity of 200,000 kva. Pit No. 1 plant, with an installed capacity of 70,000 kw., will also be visited. Delegates will be given an opportunity of also inspecting the Spaulding-Drum development of this utility.

Delegates making the trip through the Pacific Northwest will be taken over the Long Lake development of the Washington Water Power Co. at Spokane and over some of the Puget Sound Power & Light Co.'s more recent projects near Seattle. Arriving in Portland, they will be the guests of the Portland Electric Power Co. on a trip up the Columbia River Highway or an alternate trip to the Oak Grove plant of that company on the Clackamas River. This station contains the highest head-reaction turbine in the world, operating under a head of 860 feet.

No efforts are being spared in preparation for the entertainment of visitors. In addition to this the convention program promises to be one of the most noteworthy in the history of the organization.

Personal Mention

Percival Robert Moses, electrical engineer, announces that he has moved his offices to 250 Park Ave., New York City.

R. Leigh Hemingway, formerly with the Industrial Accident Commission, State of California, for eleven years, has joined the engineering staff of the Southwestern Engineering Corp., 1221 Hollingsworth Bldg., Los Angeles, Calif.

B. S. Gordon, formerly district manager of the Alabama Power Co. at Roanoke, has been appointed superintendent of local operations at the company's Anniston office to succeed L. W. Crane, recently transferred to Birmingham.

H. E. Neubauer, formerly assistant engineer of the Buffalo Foundry & Machine Co., and later vice-president of the O. S. Sleeper Co., Inc., has become associated with the Chemical & Vacuum Machinery Co., Inc., Buffalo, N. Y., as chief engineer.

C. H. Meeks, formerly chief engineer of the Port Arthur power station of the Eastern Texas Electric Co., has been transferred to the Lake Charles (La.) Electric Company, Inc., as chief engineer. Both these properties are under Stone & Webster management.

Arthur L. Mudge, who has been associated with Kerry & Chace, Ltd., consulting engineers of Toronto, for more than seventeen years as chief electrical engineer, has been appointed senior electrical engineer on the staff of the Canadian section of the joint board of engineers for the St. Lawrence deep waterways project.

W. F. Barrett, vice-president of the Union Carbide and Carbon Research Laboratories and the Carbide and Carbon Chemicals Corp. has recently received the honorary degree of Doctor of Science from the University of Pittsburgh, which was bestowed at its Charter Day exercises. The degree was given in recognition of his achievements in the production and commercialization of industrial gases.

Society Affairs

The Seattle Section of the A.I.E.E. will have as the attraction for its May 20 meeting, "Baker River Development," by L. N. Robinson.

The Baltimore Section of the A.I.E.E. will hear W. B. Potter of the General Electric Co., speak on "European Practice," at its May 15th meeting.

The Chicago Section of the A. I. & S. E. E. will hold a meeting at the Atlantic Hotel, on May 20, at which J. S. Rowan will speak on "Primary Resistance Starters for Squirrel Cage Induction Motors."

The Providence, R. I., Section of the A.S.M.E. will hear R. W. Ehrhart, of the Elliott Co., speak on "Recent Developments in Condenser Practice," at its May 12 meeting, which will be held in the Providence Engineering Society rooms, 44 Washington St.

The St. Louis Section of the A.S.M.E. will hold a dinner meeting at the Annex Hotel on May 22. A. S. Behrman, of the International Filter Co., will speak on "Boiler Scale Prevention and Removal."

The National Board of Boiler and Pressure Vessel Inspectors will hold its May 18-20 meeting at Hotel Pfister, Milwaukee, Wis. Addresses will be given by C. W. Obert, Charles E. Gorton, Fred R. Low, E. R. Fish and M. A. Edger.

A Fuel Savings Conference and Power Show will be held under the auspices of the Combustion Engineering Division of the A.I & S.E.E. on May 13-14, at the William Penn Hotel, Pittsburgh, as announced in *Power* at length in the issue of March 3, page 357.

Business Notes

The Cyrus Wm. Rice & Co., water chemists and engineers, Highland Bldg., Pittsburgh, Pa., announces the opening of a New York City office at 48 East 41st St., which will be in charge of D. C. Carmichael.

The S. Obermayer Co., 2563 West 18th St., Chicago, Ill., is enlarging its equipment for manufacturing the "Esso" brand of refractories, by the addition of a new unit which is expected to be in operation in a few months.

The Smoot Engineering Corp., 136 Liberty St., New York City, has recently appointed George B. Page & Co., 201 State Theater Bldg., Pittsburgh, Pa., sales representative for that district.

W. H. Nicholson & Co., Wilkes-Barre, Pa., manufacturers of machinery and steam specialties, announce that the sales agency for the State of Michigan has been placed with the Kilner-Mills Co., General Motors Bldg., Detroit, Mich.

The Pittsburgh Valve, Foundry & Construction Co., Pittsburgh, Pa., has moved its Chicago sales office from the Monadnock Block to the Railroad Exchange Bldg., Jackson and Michigan Boulevards. J. B. Longini is the district representative in charge.

The Bird-Archer Co., manufacturer of boiler chemicals, 33 Rector St., New York City, announces that its Canadian business will be conducted entirely from a general office at 300 McGill Bldg., Montreal, with Hugh C. Harrigin in charge. The Canadian factory and laboratory will continue to be located, as in the past seven years, at Cobourg, Ont.

The Linde Air Products Co., manufacturer and distributor of oxygen for welding and cutting and Prest-O-Lite or dissolved acetylene, New York City, announces new offices as follows: At Minneapolis, Minn., 716 First National Soo Line Bldg., C. E. Donegan, district sales manager; Birmingham, Ala., 409 Lincoln Life Bldg., W. A. K. Kopp, district sales manager; Tulsa, Okla., 508 Exchange National Bank Bldg., G. D. Grubb, district sales manager; J. W. Foster has been appointed sales manager at the Baltimore office.

The Brown Hoisting Machinery Co., Cleveland, Ohio, announces changes in its sales organization as follows: J. P. Case is sales manager and has charge of the Cleveland division sales; J. F. Poland is manager of the Chicago office; E. W. Taylor, manager of the Pittsburgh office.

The C. O. Bartlett & Snow Co., material handling and processing equipment, 6200 Harvard Ave., Cleveland, Ohio, announces that C. W. Ross, formerly with the Beaumont Co., is now manager of the Philadelphia office of the company, at 807 Schaff Bldg.

The O. E. Frank Heater & Engineering Co., designers and manufacturers of heaters, coolers, condensers and heat exchangers, 20 Milburn St., Buffalo, N. Y., announces the appointment of district representatives as follows: Geo. L. Fitz, 200 Fifth Ave., New York City; Oscar J. West, 30 N. La Salle St., Chicago, Ill.; Haynes Selling Co., Philadelphia, Pa.; The Coon-DeVisser Co., 1772 Sansom St., Detroit, Mich.; H. P. Rodgers, Leader-News Bldg., Cleveland, Ohio; Power Equipment Co., Oliver Bldg., Pittsburgh, Pa.; Vance & Vance, 510 Garrett Bldg., Baltimore, Md.; Vance & Vance, 616 Lenox Bldg., Washington, D. C.; Vance & Vance, 302 Carneal Bldg., Richmond, Va.; Vance & Vance, 506 Boxley Bldg., Roanoke, Va.; H. S. Hall, Inc., 208 Kinney Bldg., Charlotte, N. C.; Irvin H. Geiger, 212 N. 3rd St., Harrisburgh, Pa.; Steam Plant Equipment Co., 201 Mutual Bldg., Kansas City, Mo.; M. J. Haley, 593 Market St., San Francisco, Calif.

Trade Catalogs

Motors — Electric Machinery Manufacturing Co., Minneapolis, Minn. Bulletin No. 875 covers "Synchronous Motors in Pulp and Paper Mills." It is well illustrated and includes a table on synchronous speeds at different frequencies.

Insulation—Celite Products Co., 1135 Van Nuys Bldg., Los Angeles, Calif. A revised issue of its Bulletin No. 106, "The Insulation of Boilers," is announced by the company. It now includes information concerning the insulation of powdered-fuel furnaces and insulation of stacks.

Boilers—The Walsh & Weidner Boiler Co., Chattanooga, Tenn. "Calderas Tanques y Torres" is a catalog printed in Spanish, which has just been issued by this company. It is a loose-leaf, well-illustrated pamphlet which describes the boilers and tanks and pictures some of the large installations made by the company.

Sensitive Papers for Detecting Ammonia Leaks—The National Ammonia Co., St. Louis, Mo. A small booklet on ammonia, covering both anhydrous ammonia and aqua ammonia, which contains samples of papers for detecting ammonia leaks in plants, has recently been published in a revised form by the company. The booklet contains instruction for the use and care of ammonia containers, etc., of refrigerating plants and other useful information to users of ammonia and also tables of temperature, specific gravity and weight of ammonia. The booklet may be obtained free upon application to the firm.

Power Transmitting Machinery—W. A. Jones Foundry & Machine Co., 4401 West Roosevelt Road, Chicago, Ill. General catalog No. 30 is a bound volume of 500 pages giving tables of gear data, dimensions, price lists, weights and rules and tables for determining diameters and speed of rope sheaves, pulley gears and sprocket wheels. It is well illustrated and convenient for reference.

Regulating Devices — Mason Regulator Co., Dorchester Center, Boston. Mass. "Pressure Regulating Devices," or Catalog No. 62, recently published, describes the reducing valves, pump regulators, balanced valves and draft regulators manufactured by this company. A new small reducing valve for air and water recently placed on the market is fully described. Section III contains descriptions of draft regulators for controlling boiler pressures. Tables for obtaining sizes of steam-pressure reducing valves and general information of interest to users is included in this compact catalog.

Coming Conventions

American Association of Engineers. C. E. Drayer, 63 East Adams St., Chicago, Ill. Convention at Orlando, Fla., June 2-5.

American Boiler Mfg. Association, H. N. Covell, 7 East 19th Ave., Brooklyn, N. Y. Meeting at Glen Spring Hotel, Watkins, N. Y., June 1-3.

American Society for Testing Materials. C. L. Warwick, 1315 Spruce St., Philadelphia, Pa. Annual meeting at Atlantic City, Chalfonte-Haddon Hall, June 22-26.

American Institute of Electrical Engineers. F. L. Hutchinson, 29 West 39th St., New York City. Regional convention, at Swampscott, Mass., May 7-9. Annual convention at Saratoga Springs, June 22-26.

American Society of Heating & Ventilating Engineers. F. C. Houghten, 29 West 39th St., New York City. Semi-annual meeting at Traymore Hotel, Atlantic City, June 15-17.

American Society of Mechanical Engineers—Calvin W. Rice, 29 West 39th St., New York City. Spring meeting at Milwaukee, Wis., May 18-21.

American Society of Refrigerating Engineers. William H. Ross, 35 Warren St., New York City. Convention at Milwaukee, May 18-21.

Electric Power Club. S. N. Clarkson, B. F. Keith Bldg., Cleveland, Ohio. Convention at Hot Springs, Va., May 26-29.

International Railway Fuel Association. J. B. Hutchinson, Pa. R.R. System, Chicago, Ill. Seventeenth Annual Convention at Hotel Sherman, Chicago, Ill., May 26-29.

Master Boiler Makers Association. H. D. Vought, 26 Cortlandt St., New York City. Convention at Chicago, May 19-22.

Mid-West Power Show at Milwaukee, Wis., May 18-21. Ralph H. Cahill, care of Mid-West Power Show, City Hall, Milwaukee, Wis.

National Association of Stationary Engineers. F. W. Raven, 417 South Dearborn St., Chicago, Ill. National convention and exhibition at St. Paul, Minn., Aug. 31-Sept. 4. Annual conventions and exhibitions of state associations are scheduled as follows: **Pennsylvania Association** at Pittsburgh, Pa., May 15-16. Frank J. McCarron, 3647 North 11th St., Philadelphia, Pa. **Wisconsin Association** at Milwaukee, May 18-22. F. W. Horn, 256 29th St., Milwaukee, Wis. **Illinois Association at Decatur.** Olaf Jacobsen, 837 Lake Side Place, Chicago. June 3-5. **New Jersey Association** at Atlantic City, June 4-8. H. W. Vail, 1244 Park Ave., Plainfield, N. J. **New York Association** at McAlpin Hotel, New York City, June 11-13, W. T. Meinzer, 3rd St., near Warburton, Bayside, L. I. **Iowa State Association** at Ottumwa, June 16-18. F. L. Stocker, 127 S. Elm St., Ottumwa, Iowa. **New England States Association** at Worcester, Mass., July 9-11, formerly announced July 10-12. F. L. Tyler, 32 Briggs St., Taunton, Mass. **Ohio Association** at Middleton, Ohio, June 18-20. T. S. Garrett, 2622 East Second St., Dayton, Ohio. **Connecticut Association** at New Haven, June 25-27. George F. Klopfer, 30 East Pearl St., New Haven. **Michigan Association at Muskegon,** July 15-17. Charles Unterreiner, 5522 Underwood Ave., Detroit, Mich. **Minnesota Association** at St. Paul, Aug. 24-28. C. A. Nelson, 800 22nd Ave., Minneapolis, Minn.

National District Heating Association. D. L. Gaskell, Greenville, Ohio. Sixteenth annual convention at West Baden Springs Hotel, West Baden, Ind., May 19-22.

National Electric Light Association. M. H. Aylesworth, 29 West 39th St., New York City. Annual convention at San Francisco, June 15-20.

Southern Exposition—C. F. Roth. Grand Central Palace, New York City. Exposition May 11-23, at Grand Central Palace, New York City. Formerly announced for January.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; *mine run* except Pittsburgh gas slack (*Coal Age*):

Bituminous, Net Tons	Market Quoting	May 4, 1925
Pool 1	New York	$2.35@$2.75
Smokeless	Boston	1.48
Clearfield	Boston	1.75@ 2.20
Somerset	Boston	1.90@ 2.25
Kanawha	Columbus	1.35@ 1.50
Hocking	Columbus	1.35@ 1.50
Pittsburgh	Pittsburgh	1.75@ 1.90
Pittsburgh gas slack	Pittsburgh	1.40@ 1.60
Franklin, Ill.	Chicago	2.25@ 2.50
Central, Ill.	Chicago	2.00@ 2.25
Ind. 4th Vein	Chicago	2.25@ 2.50
West Ky.	Louisville	1.25@ 1.50
S. E. Ky.	Louisville	1.15@ 1.50
Big Seam	Birmingham	1.50@ 2.00
Anthracite, Gross Tons		
Buckwheat No. 1.	New York	$2.00@$2.50
Buckwheat No. 1.	Philadelphia	2.25@ 2.75
Birdseye	New York	1.40@ 1.60

FUEL OIL

New York—May 7, light oil, tank-car lots; 28@34 deg. Baumé, 5¼c. per gal.; 36@40 deg., 5½c. per gal., f.o.b. Bayonne, N. J.

St. Louis—Apr. 30, tank-car lots, f.o.b. St. Louis; 24@26 deg., $1.75 per bbl.; 26@28 deg., $1.80 per bbl.; 28@30 deg., $1.85 per bbl.; 30@32 deg., $1.90 per bbl.; 32@36 deg., gas oil, 4¾c. per gal.; 38@40 deg., 5½c. per gal.

Pittsburgh—Apr. 30, f.o.b. local refinery; 30@34 deg. fuel oil, 5c. per gal.; 36@40 deg., fuel oil, 5¾c. per gal.

Dallas—May 2, f.o.b. local refinery, 26@30 deg., $1.40 per bbl.

Philadelphia—Apr. 30, 28@30 deg. $2.21@$2.273 per bbl.; 18@22 deg., $1.90@$1.963; 13@16 deg., $1.785@ $1.85 per bbl.

Boston—May 4, tank-car lots, f.o.b. heavy oil, 12@14 deg., Baumé, 4½c. per gal.; light oil, 28@32 deg. Baumé, 5.9c. per gal.

Cincinnati—Apr. 28, tank car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5¼c. per gal.; 26@30 deg., 5½c. per gal.; 30@32 deg., 5¾c. per gal.

New Plant Construction

Calif., Cutler—Public Utility Dist., has had plans prepared for water system including pumping equipment, etc. Switzer & Moye, Visalia, are engineers.

Calif., La Jolla—The Diamond Ice Co., Spreckels Bldg., San Diego, is building a plant, here. Estimated cost $20,000. Gay Engineering Co., 2650 Santa Fe St., Los Angeles, is engineer.

Calif., Los Angeles—E. C. English, 508 Citizens National Bank Bldg., will build a 6 story apartment at 4th St. and Normandie Ave., by day labor. E. G. Martin, Citizens National Bank Bldg., is architect.

Calif., Los Angeles—Franciscan Sisters, 1223 Santee St., are having plans prepared for the construction of a 7-story hospital with steam heating system and elevators at Waterloo St. and Bellevue Ave. Estimated cost $500,000. A. C. Marlin, 227 Higgings Bldg., is architect.

Calif., Los Angeles—Seventh & Main Building Co., is receiving bids for the construction of a 12-story office and loft building, including steam heating system and elevators, on N. W. cor. 7th and Main St. Estimated cost $1,000,000. Curlett & Beelman, 408 Union Bank Bldg., are architects.

Calif., Orosi—Public Utility Dist. had plans prepared for water system including wells, pumping equipment, etc. Switzer & Moye, Visalia, are engineers.

Calif., San Mateo Co.—H. Louterbach Co., Burlingame, plans the construction of a hotel, etc., in Portola Valley, here. Estimated cost $1,000,000. Architect not selected.

Fla., Tampa—First National Bank, T. C. Taliaferro, Pres., awarded contract for the construction of a 13 story, bank and office building at Franklin and Madison Sts., to Southern Ferro Concrete Co., Atlanta, Ga., on cost plus basis. Estimated cost $1,000,000.

Ill., Chicago—H. J. Gaul, 228 East Superior St., Archt. and Engr., is taking bids for the construction of a 6 story hospital for St. Ann's Hospital, 4900 Thomas St. Estimated cost $900,000.

Ill., Chicago—Matteson & Weix, 565 Diversey Parkway, are having preliminary plans prepared for the construction of an 8-story hotel, at Webster and Sedgwick Sts. Estimated cost $1,000,000. Hooper & Janusch, 879 North State St., are architects and engineers.

Ill., Chicago—Mittelman Bros., c/o R. C. Harris, 190 North State St., Archt., is having plans prepared for the construction of a 5 story hotel on Arlington St. Estimated cost $750,000.

Ill., Chicago—Parke, Davis & Co., 2951 Atwater St., Detroit, Mich., plans the construction of a 12 story mercantile building at Randolph and Franklin Sts., here. Estimated cost $1,000,000. Architect not selected.

Ind., Indianapolis—T. A. Moynahan, Ambassador Apts., will build an 8 story office building on East Delaware St., by day labor. Estimated cost $500,000. A. Fleck, Columbian Securities Bldg., is architect.

Kan., Oswego—W. S. Fisher, is in the market for a 200 lb. capacity high pressure steam boiler.

La., Church Point—Mayor and Bd. of Aldermen will receive bids until May 20th for the construction of electric lighting system and ice plant. Estimated cost $40,000. Swanson-McGraw, United Fruit Bldg., New Orleans, consulting engineers.

La., Ruston—Lincoln Ice & Cold Storage Co., c/o Cooke and Reynolds, plans the construction of plant, to replace fire loss. Estimated cost $60,000.

Md., Baltimore—Bd. of Awards, City Hall, will receive bids until May 13th for the construction of a pumping station, filter building, etc., on Montebello Ave. V. B. Siems, is water engineer.

Mass., Boston—City, Hospital Dept., J. Manning, Pres., will soon award contract for the construction of a 9 story hospital on Albany and East Concord Sts. Estimated cost $750,000. Ritchie, Parsons & Taylor, 15 Ashburton Place, are architects.

Mass., Monson—A. D. Ellis Mills, Inc., awarded contract for the construction of a 1 and 2 story power plant including boiler house, engine room, etc., to McNally Bldg. Co., Concord Ave., Framingham. Estimated cost $50,000.

Mich., Bellaire—Village had plans prepared for the construction of a hydro-electric power house, etc. Ayes, Lewis, Norris & May, Cornwall Bldg., Ann Harbor, are engineers.

Mich., Detroit—Jefferson Avenue Corp., 8162 East Jefferson Ave., awarded contract for the construction of an 18-story apartment on Jefferson Ave., to Walbridge-Aldinger Co., 2356 Penobscot Bldg. Contractor will purchase steam heating equipment.

Mich., Detroit—G. D. Mason & Co., 80 Griswold St., Archts., are receiving bids for the construction of a 10 story office building including steam heating system, on Broadway Ave. for Sherer Estate. Farrell & White, 429 Wayne St., are engineers.

Minn., Chisholm—O. A. Borlin, village recorder, will receive bids until May 13 for 4 electrically driven centrifugal sewage pumps, with automatic starting switches, floats and controllers.

Minn., Moorhead—City plans an election May 14th to vote $135,000 bonds for the construction of a municipal light plant in business section.

Minn., Winona—Wisconsin Railway Light & Power Co., is taking bids for the construction of a boiler house, including economizer, duplex engine driven blast fan, etc. Estimated cost $40,000. Mead & Seaston, Journal Bldg., Madison, are engineers.

Mo., Kansas City — F. L. Eberhardt, Salina, Kan., is having plans prepared for the construction of an 8 story hotel, at Armour and Charlotte Sts., here. Estimated cost $750,000. S. M. Mitt, Huntzinger Bldg., Kansas City, is architect.

Mo., University City—University City Realty Co., c/o C. P. Currant, 8th and Walnut Sts., St. Louis, will build a 6-story apartment at 68th and Delmer Blvd. Estimated cost $1,000,000. P. J. Bradshaw, International Life Bldg., Archt., will award separate contracts.

N. H., Portsmouth—U. S. Treasury Dept., Washington, D. C., J. A. Wetmore, Acting Supervising Archt., will receive bids until June 8, for the furnishing and installation of two horizontal, smokeless, firebox heating boilers, arranged for portable settings, in the custom house and postoffice here.

N. J., Little Falls—Township Committee, B. S. Briggs, Clk., will receive bids until June 1, for extension of sewage system, including the construction of a pumping station, with 2 centrifugal pumps and 2 motors, accessories, etc. H. J. Harder, 129 Market St., Paterson, is engineer.

N. J., Newark—Federal Trust Co., 740 Broad St., is having plans prepared for the construction of a 16 story bank and office building including steam heating system at Commerce and Broad Sts. Estimated cost $1,250,000. G. E. Jones, 9 Clinton St., is architect. Dennison & Hirons, 228 Lexington Ave., New York City, are associate architects.

N. Y., Brooklyn—Siris & Cohen, c/o Shampan & Shampan, 188 Montague St., Archts., are having plans prepared for the construction of two 6 story apartments on Eastern Parkway. Estimated cost $750,000 each.

N. Y., New York—Y. M. C. A., 518 West 57th St., is having plans prepared for the construction of a 14-story Y. M. C. A. building, including steam heating system at 326 West 57th St. Estimated cost $1,000,000. J. F. Jackson, 137 East 45th St., is engineer and architect.

N. C., Raleigh—Sea Board Air Line Railway, Norfolk, Va., plans the construction of an icing station, and enlarging terminals, on 4-acre site here. W. D. Faucette, is chief engineer.

O., Cincinnati—Royalton Realty Co., 42 Pickering Bldg., awarded contract for the construction of a 7-story hotel on Garfield Place to Ferro Construction Co., Elm St. Estimated cost $500,000.

O., Cleveland—Collinwood Market House, c/o W. S. Watts, 4417 Woburn Ave., Archt., has had plans prepared for the construction of a market at East 156th St. and Waterloo Rd. Estimated cost $150,000. Refrigeration machinery will be purchased.

O., Cleveland—E. McGeorge, 3030 Euclid Ave., Archts., is receiving bids for the construction of a group of buildings including a boiler house, etc., for Elyria Iron & Steel Co. H. B. Wids, Pres., 232 East 131st St. Estimated cost $200,000.

Okla., Billings—City voted $20,000 bonds for waterworks improvements including new well pumps, etc. Black & Veatch, Mutual Bldg., Kansas City, Mo., are engineers.

Okla., Cherokee—City plans an election May 19th to vote $37,500 bonds for purchase of 400 hp. Diesel oil engine generator unit with accessories for municipal electric light plant.

Okla., Moore—City plans new waterworks system, including well, motor driven pumps, etc. Estimated cost $20,000. Engineer not selected.

Okla., Ponca City—C. E. Norton, City Clk., will receive bids until May 28 for a 1250 hp. Diesel Oil Engine, 850 kw. generator, and exciter, with foundations and extras.

Pa., Drexel Hill—R. Beard, 2120 Lambert St., Archt., Philadelphia, plans the construction of a 5-story apartment hotel on Plaza St. Estimated cost $1,250,000. Owner's name withheld.

Pa., New Hope—Union Mills Paper Co., Bridge St., awarded contract for the construction of a 2 story boiler house to F. B. Davis & Son, 240 North 16th St., Philadelphia.

R. I., Providence—Water Supply Board, B. T. Potter, Chn., will receive bids until May 27, for furnishing and installing 2,200 hp. water wheel for 8 ft. head; 1,500 kw. generator; switchboard; six 22,000/2,300 v. transformers; 5 and 20 ton electric cranes, wiring, etc., at or near Scituate Dam, near Village of Kent. F. E. Winsor, 661 Westminster St., is chief engineer.

Tex., Dallas—D. D. Swindle, North Texas Bldg., Archt., is preparing plans for the construction of a 15-story office building. Estimated cost $750,000. Owner's name withheld.

Tex., Dilley—Terrell Bartlett, Engineers, 612 Calcasieu Bldg., San Antonio, will receive bids about May 15, for the construction of a pumping plant, and electric generating and ice plant, for the city. Estimated cost $30,000.

Tex., Grand Rapids—City is having plans prepared for the construction of new well additional pumping equipment, etc. Estimated cost $15,000. Koch & Fowler, 606 Central Bldg., are engineers.

Tex., McAllen—Carroll College, c/o J. M. Carroll, 209 Stratford St., Pres., awarded contract for the construction of a dormitory and administration building to M. Nelson. Power house, gymnasium, etc., will be awarded later. Estimated cost $200,000.

Wash., Oroville—Okanogan Light & Power Co., plans the construction of a power and irrigation plant on the Similkaneen River, here. Plans include a dam to develop 20,000 hp. Estimated cost $350,000. E. J. Broderick is engineer.

Wash., Seattle—Great Northern Railway Co., A. W. Hogeland, Ch. Engr., 4th and Jackson Sts., St. Paul, Minn., will electrify its main line through the Cascade Mountains. Four electric motors will be purchased. Estimated cost $1,500,000. F. A. Bushnell is purchasing agent.

Wis., Milwaukee—Concrete Products Co., 6022 Plankinton Bldg., is in the market for machinery and motors for proposed new plant for manufacture of building blocks. Estimated cost $25,000.

Ont., Leamington—R. M. Selkirk, Town Clk., will receive bids until May 15th for two 75-hp. motors and pumps, etc., in connection with waterworks. Estimated cost $55,000. J. J. Newman, Davis Block, Windsor, is engineer.

Ont., Ottawa—Metropolitan Life Insurance Co., awarded contract for the construction of a 4 story office and stores building on Bank St., to G. A. Fuller Construction Co., Beaver Hall-Hill Bldg., Montreal. $1,598,800.

Ont., South Porcupine—Township of Tisdale, F. C. Evans, Town Clk., will receive bids until May 11th for the installation of a water system including pump house, etc. Estimated cost $25,000. Sutcliffe Co., Ltd., New Leskeard, is engineer.

Ont., Westboro—Independent Coal Co., Ltd., is in the market for a 125-150 hp. steam engine, Corliss type.

PRICES - MATERIALS - SUPPLIES

Electrical prices on following page are prices to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

SINCE LAST MONTH

The market for power-plant supplies is a trifle easier in such materials as iron and steel products, linseed oil and cotton waste. Firmness has developed during the past month in belting, boiler rivets, steel pipe, cement, concrete aggregates and fabricated non-ferrous metals. Rubber goods are also in active demand.

POWER-PLANT SUPPLIES

HOSE—Quotations at New York warehouses:

	Fire Protection	50-Ft. Lengths
Underwriters' 2½-in., coupled, single jacket		56c. per ft.
Common, 2½-in., cotton-rubber lined	80c. per ft. list less	45%

	Air—Best grade			
¼-in., per ft.	3-ply	$0.33	4 ply	$0.40

	Steam—Discounts from List			
First grade	40%	Second grade	40-5%	Third grade 40-10%

RUBBER BELTING—List price 6-in., 6 ply, $1.83 per lin.ft. The following discounts from list apply to rubber transmission belting:

Best grade	50-5%	Second grade	50-10-5%

LEATHER BELTING—List price, 24c. per lin.ft. per inch of width for single ply at New York warehouses.

Grade	Discount from list
Medium	30-10%
Heavy	20-5%

RAWHIDE LACING—For cut, best grade, 45-5%, 2nd grade, 55%. For laces in sides, best, 41c. per sq.ft.; 2nd, 37c. Semi-tanned: cut, 45-5%; sides, 41c. per sq.ft.

PACKING—Prices per pound at New York warehouses:

Rubber and duck for low-pressure steam, ⅛ in.	$0.90
Asbestos for high-pressure steam, ⅛ in.	1.70
Duck and rubber for piston packing	.90
Flax, regular	1.10
Flax, waterproofed	1.70
Compressed asbestos sheet	.80
Wire insertion asbestos sheet	1.30
Rubber sheet	.45
Rubber sheet, wire insertion	.70
Rubber sheet, duck insertion	.50
Rubber sheet, cloth insertion	.25
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1.30
Asbestos wick, ½- and 1-lb. balls	50

PIPE AND BOILER COVERING—Discounts, New York warehouses, are as follows:

85% magnesia high pressure		50%
For low-pressure heating and return lines	4-ply	70%
	3-ply	72%
	2-ply	74%

PORTLAND CEMENT—New York, $2.50@ $2.60 per bbl. without bags, in carload lots delivered on job. Bag charge of 40c. per bbl.

STRUCTURAL STEEL—New York delivered price, 3 to 15-in. beams and channels and 3 to 6-in. angles, tees, and plates, all $3.34 per 100 lb.

COTTON WASTE—The following prices are in cents per pound:

	New York	Cleveland	Chicago
White	15@22	19.00	.14
Colored	10.00@15.50	18.00	.09½

WIPING CLOTHS—Prices per pound in lots of about 600 lb., as follows:

	13¼ x 13¼	13¼ x 20½
Chicago	$0.11*	$0.11*
New York	17	
Cleveland (*per thousand*)	$36.00	45.00

*White, at washery.

LINSEED OIL—These prices are per gallon:

	New York	Cleveland	Chicago
Raw in barrels (5 bbl. lots)	$1.07	$1.24	$1.26

WHITE AND RED LEAD—In 100-lb. kegs, base price in cents per pound:

	Dry		In Oil	
	Current	1 Yr. Ago	Current	1 Yr. Ago
Red	15.75	15.00	17.25	16.50
White	15.75	15.00	15.75	15.00

RIVETS—The following quotations are allowed for fair-sized orders from warehouse:

Rivets, $\frac{7}{16}$x1-in. and longer, 19c. per lb., less 50% at New York warehouses. Same discount for tinned. EXTRA per 100 lb. for 1¼ to 2-in. long, all diameters, 25c.; ⅝-in. dia., 35c.; ½-in., dia., 75c.; 1-in. long and shorter, 75c.; longer than 5-in., 50c.; less than 200 lb., 50c.; countersunk heads, 45c.

Structural rivets, ½, ⅝, 1 in. diameter by 2 in. to 5 in. sell as follows per 100 lb.:
New York..... $5.00* Chicago..... $3.50 Pittsburgh... $2.50@2.60

Boiler rivets, same sizes:
New York..... $5.20* Chicago..... $3.70 Pittsburgh... $2.90

* For immediate delivery from warehouse.

REFRACTORIES—Prices in car lots f.o.b. plant:

Chrome brick, eastern shipping points	net ton	$47@52
Chrome cement, 40@ 50% Cr_2O_3, in bulk	net ton	22@27
Chrome cement, 40@ 50% Cr_2O_3, in sacks	net ton	26@31
Magnesite brick: 9-in. straights	net ton	65@68
Magnesite brick: 9-in. arches, wedges and keys	net ton	71.50@74.80
Magnesite brick: Soaps and spits	per ton	91.00@95.20
Silica brick: Mt. Union, Pa.	per M	38@40
Clay brick, 1st quality, 9 in. shapes, Pennsylvania	per M	40@47
Clay brick, 1st quality, 9 in. shapes, Ohio	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Kentucky	per M	43@45
Clay brick, 2nd quality, 9 in. shapes, Pennsylvana	per M	33@40
Clay brick, 2nd quality, 9 in. shapes, Ohio	per M	40@43
Clay brick, 2nd quality, 9 in. shapes, Kentucky	per M	40@43
Chrome ore crude, 40@50%	net ton	18.00@19.50

BABBITT METAL—Warehouse prices in cents per pound:

	New York	Cleveland	Chicago
(83% tin)	60.00	63.00	50.00
(35% tin)	28.00	20.50	28.00

COLD DRAWN STEEL—Warehouse prices are as follows:

	New York	Cleveland	Chicago
Round shafting and screw stock, per 100 lb. base	$4.15	$4.00	$3.80
Flats, squares and hexagons, per 100 lb. base	4.65	4.50	4.30

BOILER SPECIALTIES—F. o. b. New York or Jersey City, discounts on list:

	Current
Copper ferrules	70%
Boiler flanges	60-10%
Boiler stay bolts	60%
Boiler patch bolts	10%
Boiler fitting-up bolts	45%
Pressed steel boiler lugs	10%
Pressed steel boiler hangers	10%

WROUGHT PIPE—The following discounts are to jobbers for carload lots at Pittsburgh mill:

BUTT WELD

Inches	Steel Black	Steel Galv.	Inches	Iron Black	Iron Galv.
1 to 3	62	50½	1 to 1½	39	13

LAP WELD

2	55	43½	2	23	7
2½ to 6	59	47½	2½	26	11
7 and 8	56	43½	3 to 6	28	13
9 and 10	54	41½	7 to 12	26	11
11 and 12	53	40½			

BUTT WELD, EXTRA STRONG, PLAIN ENDS

1 to 1½	60	49½	1 to 1½	30	14
2 and 3	61	50½			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	53	42½	2	23	9
2½ to 4	57	46½	2½ to 4	29	15
4½ to 6	56	45½	4½ to 6	28	14
7 and 8	52	39½	7 and 8	21	7
9 and 10	45	32½	9 to 12	16	2
11 and 12	44	31½			

BOILER TUBES—Following are prices in New York warehouse of tubes manufactured according to specifications of the American Society of Mechanical Engineers:

Size	Lapweld Steel	C. C. Iron	Seamless Steel
1	.....	.....	$17 07
1¼	.....	.....	19 20
1½	.....	$38.00	17 92
1¾	.....	28 50	20 48
2	$17.33	25 00	20 24
2¼	19 84	28 25	23 00
2½	21 60	34 00	26 03
3	25.50	42 50	27 04
3¼	.....	49 50	30 67
3½	31.50	52 75	33 33
4	38.03	67.00	40.11

Tubes 2½ in. diameter, or smaller, over 18 ft. long, 10 per cent extra.

These prices are net per 100 ft. based on stock lengths. If cut to special lengths, billing will be based on the entire stock lengths.

In addition to the above, standard cutting charges are as follows:

2 in. and smaller, 5c. per cut. 3 in., 9c. per cut
2¼ and 2½ in., 6c. per cut. 3½ to 4 in., 10c. per cut

ELECTRICAL SUPPLIES

ARMORED CABLE—Price per 1,000 ft.—5 per cent 10 days.

B. & S. Size	Two Cond. M Ft.	Three Cond. M Ft.	Two Cond. Lead M Ft.	Three Cond. Lead M Ft.
No. 14 solid	$37.50 (net)	$ 52.00 (net)	$164.00	$210.00
No. 12 solid	135.00	170.00	225.00	265.00
No. 10 solid	185.00	235.00	275.00	325.00
No. 8 stranded	285.00	375.00	520.00	500.00
No. 6 stranded	400.00	500.00	560.00	.....

From the above lists discounts are:		Lead Covered
Less than coil lots	50%	25%
Coils to 1,000 ft.	55%	30%
1,000 to 5,000 ft.	60%	35%
5,000 ft. and over	60–5%	40%

CONDUIT, Price per 1,000 ft.; **ELBOWS AND COUPLINGS**, Per 100 pieces, f.o.b. New York, with 10-day discount of 5 per cent.

Size In.	Conduit Black Per M	Conduit Galvanized Per M	Elbows Black Per C	Elbows Galvanized Per C	Couplings Black Per C	Couplings Galvanized Per C
¼	$56.50	$61.34	$7.76	$8.83	$4.52	$4.92
⅜	72.07	78.63	10.21	11.63	6.46	7.03
½	103.31	113.00	15.10	17.21	8.39	9.13
¾	139.77	152.88	20.51	23.07	11.78	12.75
1	167.12	182.79	27.34	30.76	14.56	15.75
1¼	224.85	245.94	50.13	56.40	19.41	21.01
1½	355.50	388.85	82.03	92.28	27.73	30.01
2	464.88	508.50	218.74	246.10	41.59	45.01
2½	585.30	637.74	483.04	543.46	55.46	60.02
3	714.17	776.30	558.23	628.06	69.32	75.02

CONDUIT BODIES AND FITTINGS—Black or galvanized.

	Less than $10 list	$10 list to $100	$100 list and over
Standard package	10%	20%	28%
Less than standard package	5%	10%	20%

CUT-OUTS—Following are net prices each in standard-package quantities:

CUT-OUTS, PLUG

S. P. M. L.	$0.12	D. P. D. B.	$0.31
D. P. M. L.	.16	T. P. S. B.	.35
T. P. M. L.	.27	T. P. D. B.	.47
D. P. S. B.	.16		

CUT-OUTS, N. E. C. FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp.
D. P. M. L.	$0.27	$0.70	$1.75
T. P. M. L.	.40	1.00	2.30
D. P. S. B.	.35	.87	.....
T. P. S. B.	.67	1.50	.....
D. P. D. B.	.65	1.75	.....
T. P. D. B.	1.12	3.00	.....
T. P. to D. P. D. B.	.75	2.10	.....

FLEXIBLE CORD—Price per 1,000 ft. in coils of 250 ft.:

No. 18 cotton reinforced heavy	$23.00
No. 16 cotton reinforced heavy	26.50
No. 18 cotton reinforced light	18.25
No. 16 cotton reinforced light	23.00
No. 18 cotton Canvasite cord	17.50
No. 16 cotton Canvasite cord	20.50

NATIONAL ELECTRIC CODE FUSES, NON-REFILLABLE—

250-Volt	Std. Pkg.	List	600-Volt	Std. Pkg.	List
3-amp. to 30-amp.	100	$0.15	3-amp. to 30-amp.	100	$0.30
35-amp. to 60-amp.	100	.30	35-amp. to 60-amp.	100	.60
61-amp. to 100-amp.	50	.90	65-amp. to 100-amp.	50	1.50
101-amp. to 200-amp.	25	2.00	110-amp. to 200-amp.	25	2.50
201-amp. to 400-amp.	25	3.60	225-amp. to 400-amp.	25	5.50
401-amp. to 600-amp.	10	5.50	450-amp. to 600-amp.	10	8.00

Discount: Less 1-5th standard package, 55%; 1-5th to standard package, 60%; standard package, 65%.

RENEWABLE FUSES, ENCLOSED—List price each:

Sizes	250-Volt List-Price	600-Volt List-Price	Std. Pkg. Quantity	Carton Quantity
1 to 30-amp.	$0.50	$1.10	100	10
35 to 60-amp.	1.00	1.25	100	10
65 to 100-amp.	2.00	3.00	50	5
110 to 200-amp.	4.00	5.00	25	5
225 to 400-amp.	7.50	11.00	25	1
450 to 600-amp.	11.00	16.00	10	1
450 to 600-amp.	11.00	16.00	10	1

REFILLS—

1 to 30	$0.30 ea.	$0.05	100	100
35 to 60	.05 ea.	.06	100	100
65 to 100	.10 ea.	.10	50	50
110 to 200	.15 ea.	.15	25	50
225 to 400	.30 ea.	.30	25	25
450 to 600	.60 ea.	.60	10	10

Discount Without Contract—Fuses:	
Broken carton	5%
Unbroken carton but less than std. pkg.	22%
Std. pkg.	40%
Discount Without Contract—Renewals:	
Less than std. pkg.	Net list
Standard package	40%
Discount With Contract—Fuses:	
Broken cartons	10%
Unbroken cartons but less than standard package	26%
Standard package	42%
Discount With Contract—Renewals:	
Less standard package	Net list
Standard package	42%

FUSE PLUGS, MICA CAP—

0-30 ampere, standard package (500)	$2.85
0-30 ampere, less than standard package	3.15

LAMPS—Below are present quotations in less than standard package quantities:

Straight-Side Bulbs — Mazda B— Watts	Plain	Frosted	No. in Package	Pear-Shaped Bulbs or Bowl Enameled Mazda C— Watts	Clear	Frosted	No. in Package
10	$0.27	$0.32	120	50	$0.40	$0.45	60
15	.27	.32	120	75	.45	.55	60
25	.27	.32	120	100	.50	.55	24
40	.27	.32	120	150	.65	.70	24
50	.27	.32	120	200	.80	.85	24
60	.32	.37	120	300	1.25	1.35	24
				500	2.00	2.15	12
				750	3.50	3.70	8
				1,000	3.75	3.95	8

Standard pkg. quantities are subject to discount of 10% from list. Annual contracts ranging from $75.00 to $300,000 net allow a discount of 15 to 40% from list.

PLUGS, ATTACHMENT—

	Each
Porcelain separable attachment plug	$0.18
Composition 2-piece attachment plug	.27
Swivel attachment plug	.12
Small size—2 Pc. Plug—Composition	08½

RUBBER-COVERED COPPER WIRE—Per 1000 ft. f. o. b. New York:

No.	Solid Single Braid	Solid Double Braid	Stranded, Double Braid	Duplex
14	$6.85	$9.01	$10.75	$17.25
12	8.96	11.60	13.40	22.25
10	12.14	18.42	17.20	29.60
8	17.50	20.98	22.60	41.58
6	.....	.....	32.45	.....
4	.....	.....	45.80	.....
2	.....	.....	68.00	.....
1	.....	.....	86.95	.....
0	.....	.....	112.60	.....
00	.....	.....	133.00	.....
000	.....	.....	159.00	.....
0000	.....	.....	189.00	.....

SOCKETS, BRASS SHELL—

½ In. or Pendant Cap — Key Each	Keyless Each	Pull Each	¾ In. Cap — Key Each	Keyless Each	Pull Each
$0.33	$0.30	$0.55	$0.39	$0.36	$0.61

Less 1-5th standard package	25%
1-5th to standard package	32%
Standard package	37%

WIRING SUPPLIES—

Friction tape, ¾ in., less 100 lb. 33c. lb., 100 lb. lots	31c. lb.
Rubber tape, ¾ in., less 100 lb. 33c. lb., 100 lb. lots	31c. lb.
Wire solder, less 100 lb. 27c. lb., 100 lb. lots	29c. lb.
Soldering paste, 2 oz. cans	$1.00 doz.

ENCLOSED SWITCHES, KNIFE—Safety type, externally operated, 250 d.c or a.c., N.E.C.

TYPE "C" FUSED BOTTOM

Size, Amp.	Double Pole, Each	Three Pole, Each	Four Pole, Each
30	$4.50	$6.00	$7.25
60	7.50	8.25	10.50
100	10.50	13.00	22.50
200	16.00	20.00	36.00

Discounts:	
Less than $25.00 list value	30%
$25 to $50 list value	30–5%
$50 list value or over	35%